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D5.3 Resilience assessment of current farming systems across the European Union

Work performed by all partners (lead P1 WU)

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INDEX

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1 ABSTRACT

For improving sustainability and resilience of EU farming system, the current state needs to be assessed, before being able to move on to future scenarios. Assessing sustainability and resilience of farming systems is a multi-faceted research challenge in terms of the scientific domains and scales of integration (farm, household, farming system level) that need to be covered. Hence, in SURE-Farm, multiple approaches are used to evaluate current sustainability and resilience and its underlying structures and drivers. To maintain consistency across the different approaches, all approaches are connected to a resilience framework which was developed for the unique purposes of SURE-Farm. The resilience framework follows five steps: 1) the farming system (resilience of what?), 2) challenges (resilience to what?), 3) functions (resilience for what purpose?), 4) resilience capacities, 5) resilience attributes (what enhances resilience?). The framework was operationalized in 11 case studies across the EU.

Applied approaches differ in disciplinary orientation and the farming system process they focus on. Three approaches focus on risk management: 1) a farm survey with a main focus on risk management and risk management strategies, 2) interviews on farmers' learning capacity and networks of influence, and 3) Focus Groups on risk management. Two approaches address farm demographics: 4) interviews on farm demographics, and 5) AgriPoliS Focus Group workshops on structural change of farming systems from a (farm) demographics perspective. One approach applied so far addresses governance: 6) the Resilience Assessment Tool that evaluates how policies and legislation support resilience of farming systems. Two methods address agricultural production and delivery of public and private goods: 7) the Framework of Participatory Impact Assessment for sustainable and resilient farming systems (FoPIA-SURE-Farm), aiming to integrate multiple perspectives at farming system level, and 8) the Ecosystem Services assessment that evaluates the delivery of public and private goods. In a few case studies, additional methods were applied. Specifically, in the Italian case study, additional statistical approaches were used to increase the support for risk management options (Appendix A and Appendix B).

Results of the different methods were compared and synthesized per step of the resilience framework. Synthesized results were used to determine the position of the farming system in the adaptive cycle, i.e. in the exploitation, conservation, release, or reorganization phase. Dependent on the current phase of the farming system, strategies for improving sustainability and resilience were developed.

Results were synthesized around the three aspects characterizing the SURE-Farm framework, i.e. (i) it studies resilience at the farming system level, (ii) considers three resilience capacities, and (iii) assesses resilience in the context of the (changing) functions of the system.

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(i) *Many actors are part of the farming system. However, resilience-enhancing strategies are mostly defined at the farm level.* In each farming system multiple actors are considered to be part of the system, such as consultants, neighbors, local selling networks and nature organizations. The number of different farming system actors beyond the focal farmers varies between 4 (in French beef and Italian hazelnut systems) and 14 (large-scale arable systems in the UK). These large numbers of actors illustrate the relevance of looking at farming system level rather than at farm level. It also suggests that discussions about resilience and future strategies need to embrace all of these actors.

(ii) *At system level there is a low perceived capacity to transform.* Yet, most systems appear to be at the start of a period in which (incremental) transformation is required. At system level, the capacity to transform is perceived to be relatively low, except in the Romanian mixed farming system. The latter may reflect a combination of ample room to grow and a relatively stable environment (especially when compared to the past 30 to 50 years). The relatively low capacity to transform in the majority of systems is not in line with the suggestion that most systems are at the start of (incremental) transformation, or, at least, reached a situation in which they can no longer grow. Further growth is only deemed possible in the Belgium dairy, Italian hazelnut, Polish fruit and Romanian mixed farming systems.

(iii) *System functions score well with regard to the delivery of high-quality and safe food but face problems with quality of rural life and protecting biodiversity.* Resilience capacities can only be understood in the context of the functions to be delivered by a farming system. We find that across all systems required functions are a mix of private and public goods. With regard to the capacity to deliver private goods, all systems perform well with respect to high-quality and safe food. Viability of farm income is regarded moderate or low in the livestock systems in Belgium (dairy), France (beef) and Sweden (broilers), and the fruit farming system in Poland. Across all functions, attention is especially needed for the delivery of public goods. More specifically the quality of rural life and infrastructure are frequently classified as being important, but currently performing bad. Despite the concerns about the delivery of public goods, many future strategies still focus on improving the delivery of private goods. Suggestions in the area of public goods include among others the implementation of conservation farming in the UK arable system, improved water management in the Italian hazelnut system, and introduction of technologies which reduce the use of herbicides in Polish fruit systems. It is questionable whether these are sufficient to address the need to improve the maintenance of natural resources, biodiversity and attractiveness of rural areas. With regard to the changing of functions over time, we did not find evidence for this in our farming systems.

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2 INTRODUCTION

Farming systems in Europe face a variety of economic, ecological and societal challenges, raising concerns about the resilience of farming systems to shocks and stresses. These resilience concerns need to be addressed with a focus on the regional context in which farming systems operate because farms, farmers' organizations, service suppliers and other supply chain actors are embedded in local environments and functions of agriculture (Meuwissen et al., 2019).

In the SURE-Farm project, a framework was developed to assess the resilience of Europe's diverse farming systems (Meuwissen et al., 2019). The framework deploys a mixed-methods approach: quantitative methods are used to identify underlying patterns, causal explanations and likely contributing factors; while qualitative methods access experiential and contextual knowledge and provide more nuanced insights. Analysis along the framework explores multiple nested levels of farming systems (e.g. farmer, farm, farm household, farming system) over a time horizon of 1-2 generations, thereby enabling reflection on potential trade-offs in time and between scales (farm, household, farming system) at which resilience attributes influence the system. Eleven case studies across the European Union were selected to provide a rich and diverse picture.

The aim of this report is to assess the resilience and the delivery of public and private goods of current farming systems across the European Union. D5.1 (Herrera et al., 2018) provided an overview of the tools available in WP5. According to D5.1, four tools were appropriate for assessing past and current resilience: FoPIA-SURE-Farm, Ecosystem Services modelling, stochastic modelling and statistical modelling. In the research proposal, also the use of TechnoGIN and FSSIM were mentioned, with the aim to compare current state of farming systems to optimal solutions according to stakeholders' objectives. TechnoGIN and FSSIM were however not used, because of large data requirements, and because the associated aim was largely covered by the Ecosystem Services modelling.

Both FoPIA-SURE-Farm (Paas et al., 2019) and the Ecosystem Services modelling have been applied to (almost) all case studies. As the stochastic and statistical modelling are data demanding, these tools have only been applied to specific case studies (see Appendices). In this report, the results of these WP5 tools are complemented by methods used in WP2, WP3 and WP4. All these methods together provide a rich picture of the resilience and delivery of public and private goods in eleven case studies. The focus in this report is on current farming systems; future scenarios and the impact of specific policy options and strategies will be further explored in D5.5 and D5.6.

This reports continues with a description of the methods applied. The following chapters include assessments of all 11 case studies. After that, a cross-case-study comparison of current ecosystem service provision is provided. The report finishes with a synthesis of results, including lessons

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learned, a reflection on why this new framework was needed, and additional steps to be taken in the SURE-Farm project. Tools and applications that are only used in specific case studies are not part of the main report, but are presented in Appendices.

3 METHODS

3.1 RESILIENCE FRAMEWORK AND OPERATIONALIZATION

The assessment of resilience and the delivery of public and private goods follows the framework as developed by (Meuwissen et al., 2019) and presented in Figure 3.1. As farming systems are not only influenced by challenges, but also by opportunities, the latter are also identified. Results regarding all steps are used to identify in which phase of the adaptive cycle (different processes of) the farming system is. In addition, strategies that enhance resilience and are promising for the future are identified. Table 3.1 provides an overview of the methods that have been used in all case studies, and how they relate to the different steps of the framework. The methods are complemented by data and literature, and in some case studies additional methods have been used, including biographical narratives (Coopmans et al., 2019b) and specific modelling approaches (see Appendices). Each step is described in detail in the following sections; for details about the methods, the reader is referred to specific reports.

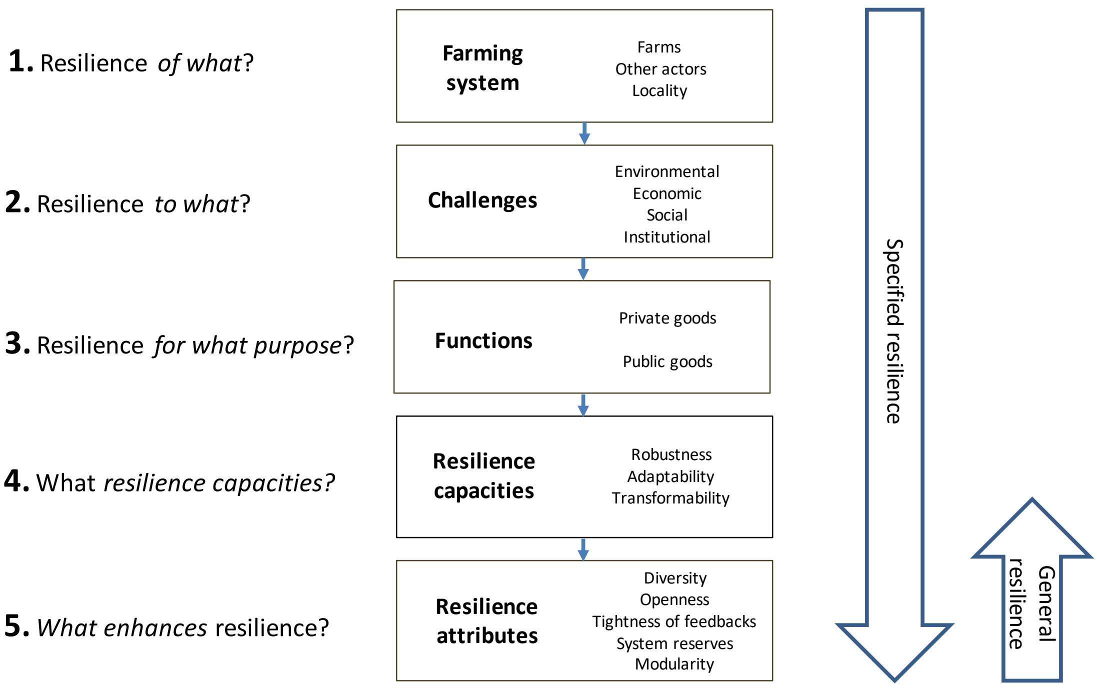

Figure 3.1 Framework to assess resilience of farming systems (Source: Meuwissen et al., 2019).

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Table 3.1. Methods used to address different steps of the resilience framework. T refers to the task in the project; RM refers to risk management, and ES to ecosystem services. Details are provided in the main text.

Method **Level**	**T2.1 Farm survey** **Farmers**	**T2.2 Learning interviews** **Farmers**	**T2.4 Focus group RM** **Farming system**	**T3.1 Demographic interviews** **Farmers & households**	**T3.2 Focus group AgriPoliS** **Farming system & farmers**	**T4.1 ResAT** **Farming system**	**T5.2 FoPIA-SURE-Farm 1** **Farming system**	**T5.2 ES modelling** **Farming system**
Farming system			Farming system actors were presented and discussed with stakeholders				Farming system actors were presented and discussed with stakeholders	Cells of 10x10 km were selected for representation
Challenges & opportunities	Mention the three most important challenges & score the perception of different types of challenges for the next 20 years	Interpretation by researcher derived from interviews		Mention past and future challenges & opportunities	Interpretation by researcher derived from discussion	Policy document analysis	Researchers prepared a list of challenges before the workshop . Along sketching indicator dynamics, challenges and opportunities were determined.	
Functions		No specific questions, but interviews may reveal what farmers think about functions		Interpretation by researcher derived from interviews	Interpretation by researcher derived from discussion			
-Importance	100 points were divided over 8 functions.						100 points were divided over 8 functions. Per function, 100 points were divided over the selected indicators	
-Performance							Performance of 2-4 selected indicators per function were assessed on a scale from 1-5	Data at grid level across the EU were used to estimate the performance of 5 private and 9 public goods
Resilience capacities	Score the level of resilience capacities in the farms, by (dis)agreeing with sentences using a score from 1 to 7	Interpretation by researcher derived from interviews	Given the actor's role in specific RM strategies: assess how actors contribute to capacities on scale from -3 to +3	Interpretation by researcher derived from interviews		The capacity of policies to enhance resilience capacities of the farming system was assessed with ResAT, based on 4 attributes per capacity, distinguishing between goals and instruments	Implementation of identified strategies was scored from 1-5, and contribution to resilience capacities from -3 to +3. Also, 13 resilience attributes were evaluated regarding their presence (1-5) and contribution to resilience capacities (-3 to +3).	

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Method	T2.1 Farm survey	T2.2 Learning interviews	T2.4 Focus group RM	T3.1 Demographic interviews	T3.2 Focus group AgriPoliS	T4.1 ResAT	T5.2 FoPIA-SURE-Farm 1	T5.2 ES modelling
Level	**Farmers**	**Farmers**	**Farming system**	**Farmers & households**	**Farming system & farmers**	**Farming system**	**Farming system**	**Farming system**
Attributes	RM: select from a list which on-farm or shared strategies have been adopted in the last 5 years. Networks: score the relevance of sentences related to networks. Propension for innovation: score agricultural practices, new technologies and varieties from 1 to 7	Interpretation by researcher derived from interviews	Interpretation of strategies	Interpretation by researcher derived from interviews		The attributes are the key characteristics for resilience-enhancing policies displayed in the ResAT-wheel. The given colour (+ score) indicate to what extent the key characteristic is enhancing or constraining the resilience (4 per capacity)	13 selected resilience attributes were evaluated regarding their presence (1-5) and contribution to resilience capacities (-3 to +3). These attributes were linked to 5 generic resilience attributes and 4 SURE-Farm processes	
Adaptive cycle							Can be concluded from results	
Strategies (future)	Mention the three most important (challenges and) strategies for the next 20 years	Future strategies can emerge from the interviews	Assess how RM strategies can be improved incl. role of actors	Mention (past and) future strategies	Future strategies can emerge from the focus group		Section in discussion, based on position in adaptive cycle and successful previous strategies	

3.2 FARMING SYSTEM

SURE-Farm has 11 case studies across the EU (Figure 3.2). Farming systems are described based on their location, main sector(s), farm type(s), products and challenge(s). Farms and other actors in the farming system mutually influence each other, while context actors either influence farms or are influenced by farms unilaterally. During the FoPIA-SURE-Farm 1 workshop (Paas et al., 2019) and the focus group on risk management (D2.6; Soriano et al., 2019), the main farming system actors were presented and discussed with stakeholders. For the ecosystem services assessment, the farming systems were delineated based on grid cells of 10 x 10 km^2.

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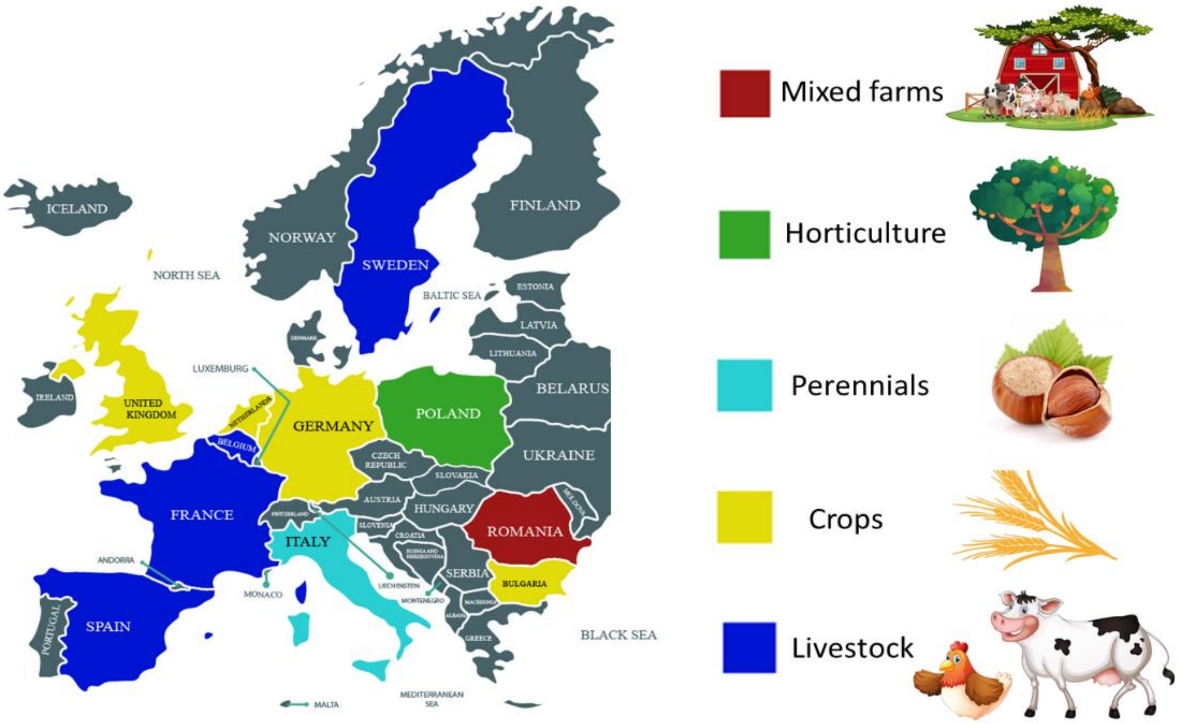
a)



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 crop farms	Arable farming	Large-scale corporate farms	Small scale Hazelnut production	Private family fruit and vegetable farms	Small scale farms

b)

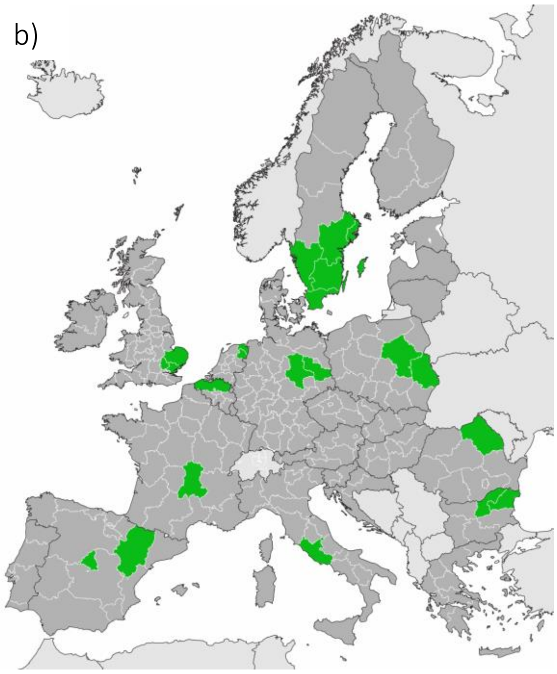


Figure 3.2. SURE-Farm case studies across the EU, with a) country and sector, and b) location based on NUTS2 regions.

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3.3 CHALLENGES AND OPPORTUNITIES

We distinguish between economic, environmental, social and institutional challenges; as well as shocks and long-term stresses. Shocks might have irreversible or only temporary effects on farming system functions. Long-term stresses are associated with gradual change in performance of the system's functions.

In a farm survey (Spiegel et al., 2019), key challenges were assessed in two ways. Firstly, an open question on major challenges was raised, in order to avoid influencing respondents by a pre-defined categorization of challenges. Secondly, participants were asked to assess the relevance of pre-defined list of challenges based on a 7-point-Likert-type item (Table 3.3). These challenges were categorized. For each category of challenges in each case study region the mean of all observations was calculated.

Table 3.3. Predefined challenges included in the farm survey and their categorization (Source: Spiegel et al., 2019).

Category of challenges	Sub-questions in the survey related to the respective class of challenges (full statement as in the survey)
Economic	Persistently low market prices Persistently high input prices (e.g. fertiliser, feed, seed) Market price fluctuations Low bargaining power towards processors and retailers Input price fluctuations (e.g., fertiliser, feed, seed) Low bargaining power towards input suppliers (e.g., fertiliser, feed, seed suppliers) Limited access to loans from banks Late payments from buyers
Environmental	Persistent extreme weather events (e.g., floods, droughts, frost) Pest, weed, or disease outbreaks Low soil quality
Institutional	Reduction in direct payments of the Common Agricultural Policy (CAP) Strict regulation (e.g., environmental, animal welfare, or competition)
Social	Public distrust in agriculture Low societal acceptance of agriculture Limited availability of skilled farm workers Limited ability to work on the farm due to illness, divorce or other personal circumstances

One of the aims of the interviews on learning capacity and networks of influence (Urquhart et al., 2019) was to identify the challenges that respondents face, raising a series of semi-structured questions, such as "What type of risks do you have to manage? What were the challenges being faced?" or "What sort of risks are you most concerned about? What are the most frequent?". A similar strategy was followed during the demographic interviews (Coopmans et al., 2019b) and the AgriPoliS Focus Group workshop (Pitson, 2018) that however focused on farm demographic decisions and related internal and external factors that are influencing the farm business situation

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(for demographic interviews) and demographic change in the region (for AgriPoliS focus group workshop). It is important to note that participants mentioned not only challenges, but also opportunities, i.e., positive factors and drivers. In contrast to the other methods, the Resilience Assessment Tool (ResAT; Termeer et al., 2018b) asks researchers to identify the specific challenges that the farming system(s) face(s) in the regional context based on the available literature and expert interviews.

The FoPIA-SURE-Farm 1 workshop was the only method specifically dealing with challenges in the past (Paas et al., 2019). In the preparation phase, literature and expert interviews were used to identify main challenges for the farming system, using the SURE-Farm categorization as mentioned above. During the workshop, historical dynamics of main indicators, representing important functions of the farming system, were sketched from 2000-2018, and both challenges and opportunities that influenced the level of the indicators were identified.

3.4 ESSENTIAL FUNCTIONS

We assume that farming systems generally provide multiple functions and distinguish between provision of private and public goods as essential farming system's functions. Private goods include production of food and ensuring reasonable income from farming. Public goods include maintaining natural resources in good conditions and animal welfare. The ability of the farming system to deliver the desired performance of functions, and thus sustainability, could be impeded by challenges. We assessed both the importance and performance of every function.

The farm survey targeted the importance of essential functions (Spiegel et al., 2019). In particular, farmers were asked to distribute 100 points among eight predefined functions: (i) Deliver high quality food products; (ii) Deliver bio-based resources (e.g., hemp, wood) to produce biomass and biofuels; (iii) Ensure a sufficient farm income; (iv) Provide employment and good working conditions for employees; (v) Maintain natural resources (e.g. water, air, soil) in good condition; (vi) Protect biodiversity; (vii) Ensure the attractiveness of rural areas in terms of agro-tourism and residence; (viii) Ensure animal welfare. The total score for each function in each case study region was calculated as the mean of all observations. Learning interviews also focused on importance (Urquhart et al., 2019), aiming to better understand farmer attitudes, values and motivations.

In contrast, the demographic interviews assessed performance of essential functions (Coopmans et al., 2019b), providing a deeper understanding of major factors shaping farm demographics that occur throughout Europe. For ecosystem services assessment, data at grid level across the EU were used to estimate the performance of five private (i.e., food crop production; fodder crop production; energy crop production; grazing livestock density; and timber removal) and nine public goods (i.e., habitat quality based on common birds; pollination potential; water retention

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index; equilibrium phosphorous concentration; organic matter in topsoil concentration; carbon storage; recreation; NOx retention capacity; and capacity to avoid soil erosion).

The FoPIA-SURE-Farm 1 workshop (Paas et al., 2019) was the only method targeting both importance and performance of essential functions. During the preparation phase, researchers identified two to four indicators per (eight) essential function. This selection was discussed with stakeholders, for whom these indicators are essential. During the workshop, stakeholders were asked to rank both the perceived importance of the eight functions, as well as importance of suggested indicators within each function by distributing 100 points. A transformation allowed the comparison of importance of indicators. Afterwards, stakeholders were asked to assess the current performance of the indicators, scoring from 1 to 5, where 1: very low performance, 2: low performance, 3: medium performance, 4: good performance, 5: perfect performance.

3.5 RESILIENCE CAPACITIES

Three resilience capacities were defined in SURE-Farm (Meuwissen et al., 2019):

- Robustness is defined as the farming system's capacity to withstand stresses and (un)anticipated shocks.
- Adaptability is defined as the capacity to change the composition of inputs, production, marketing and risk management in response to shocks and stresses but without changing the structures and feedback mechanisms of the farming system
- Transformability is defined as the capacity to significantly change the internal structure and feedback mechanisms of the farming system in response to either severe shocks or enduring stress that make business as usual impossible. Such transformations may also entail changes in the functions of the farming system.

At farm level, three methods were used to reveal resilience capacities. In the farm survey, farmers were asked to score the perceived level of resilience capacities in the farms, by (dis)agreeing with sentences using a score from 1 to 7 (Spiegel et al., 2019). Per capacity, 4 statements were provided (e.g. 'as a farmer, I can easily adapt myself to challenging conditions'). Learning interviews and demographic interviews provided statements that were interpreted by researchers by way of abductive reasoning (Tavory and Timmermans, 2014). Demographic interviews also provided the perspective of other members of the farm household. While respondents might not necessarily use the terminology of robustness, adaptability and transformability, the researchers attributed these resilience capacities when reconstructing the narrative. The validity and reliability of the resilience analysis was enhanced through iterative and dialogical interpretation, both among multiple researchers and with stakeholders (Wagenaar, 2011).

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At farming system level, two methods provided information on resilience capacities. In a participatory workshop (FoPIA-SURE-Farm 1), perceptions of stakeholders regarding resilience capacities were revealed based on sketches of historical dynamics, applied strategies in the past, and the presence of resilience attributes and their contribution to the capacities (Paas et al., 2019). When sketching historical dynamics, strategies were identified that were applied to cope with challenges influencing main indicators. For each strategy, it was evaluated how well they were implemented using a score from 1-5, and how they contributed to the three resilience capacities, using a score from -3 to +3. In addition, 13 selected resilience attributes were evaluated regarding their presence (1-5) and contribution to resilience capacities (-3 to +3). The other method was the Resilience Assessment Tool (ResAT), which assessed the capacity of policies to enhance resilience capacities of the farming system, based on 4 attributes per capacity, distinguishing between policy goals and policy instruments (Termeer et al., 2018).

3.6 RESILIENCE ATTRIBUTES

With regard to the enhancing attributes two approaches were used: (i) after defining specific attributes we explored their current state, contribution to resilience capacities, and potential improvements; and (ii) building on the assessment of resilience capacities we inferred resilience enhancing attributes (e.g. which collective competences enhance transformation), their current state and potential improvements. Attributes were then framed in the context of the generic principles of resilience, i.e. diversity, openness, tightness of feedbacks, system reserves, and modularity (Resilience Alliance, 2010).

Approach (i) was used in ResAT and FoPIA-SURE-Farm 1. ResAT assessed 12 attributes, including 'short-term focus', 'protecting status quo', 'buffer resources', 'risk management' (related to robustness), middle-term focus', flexibility', 'variety and tailor-made responses', 'social learning' (related to adaptability), long-term focus', dismantling status quo', in-depth learning' and 'accelerating niche innovation'(related to transformability). The FoPIA-SURE-Farm approach included the following 13 attributes, mainly adapted from Cabell and Oelofse (2012): (1) 'reasonably profitable' indicating that farmers and farm workers earn a liveable wage while not depending heavily on subsidies (system reserves), (2) 'production is coupled with local and natural capital' indicating that soil fertility, water resources and existing nature are maintained well (system reserves); (3) 'functional diversity' reflecting that there is a high variety of inputs, outputs, income sources and markets (diversity); (4) 'response diversity' indicating that there is a high diversity of risk management strategies, e.g. different pest controls, weather insurance, flexible payment arrangements (diversity); (5) 'exposed to disturbance' indicating that the amount of year to year economic, environmental, social or institutional disturbance is small (well dosed) in order to timely adapt to a changing environment (openness); (6) 'spatial and temporal heterogeneity of

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farm types' indicating that there is a high diversity of farm types with regard to economic size, intensity, orientation and degree of specialization (modularity, diversity); (7) 'supports rural life' reflecting that farmers can stop without endangering continuation of the farming system and new farmers can enter the farming system easily (system reserves); (8) 'socially self-organized' showing that rural life is supported by the presence of people from all generations, and also supported by enough facilities in the nearby area such as supermarkets, hospital, schools, shops (system reserves); (9) 'appropriately connected with actors outside the farming system' indicating that farmers are able to organize themselves into networks and institutions such as coops, farmer's markets, community sustainability associations, and advisory networks (tightness of feedbacks); (10) 'appropriately connected with actors outside the farming system' indicating that farmers and other actors in the farming system are able to reach out to policy makers, suppliers, finance providers and markets that operate at the national and EU level (tightness of feedbacks); (11) 'legislation which is coupled with local and natural capital' indicating that norms, legislation and regulatory frameworks are well adapted to the local conditions (system reserves); (12) 'infrastructure for innovation' reflecting that existing infrastructure facilitates knowledge and adoption of cutting-edge technologies (e.g. digital) (openness, system reserves); and (13) diverse policies indicating that policies stimulate all three capacities of resilience, i.e. robustness, adaptability, transformability (diversity).

Approach (ii), i.e. inferring attributes from the resilience capacities has been used with regard to the farm survey, including questions on diversity of agricultural activities and risk management strategies, integration in networks and openness to innovation, and questions which can give an indication about system reserves (having a successor, adoption of organic agricultural practices, availability of hired labour). Also, with regard to the learning interviews with farmers, and the demographic interviews with farmers as well as other household members, this approach was used. In the survey we distinguish arable and dairy farmers.

With regard to the constraining attributes, evidence is collected 'along the way' through (i) identifying 'what is not working' with regard to resilience capacities and attributes; and (ii) reflecting on trade-offs across resilience capacities (e.g. enhancing robustness at the expense of transformability) and (intended or unintended) externalities across levels (e.g. enhancing the robustness of a value chain by forcing costly transformation upon its members).

The five generic principles of resilience are defined in a highly generic way. Although this was done on purpose, i.e. to allow relevance across a wide variety of farming systems and to give room for context-specific variation and surprise, it needs to be avoided that the principles become empty shells. Researchers therefore have to acknowledge that each of the principles can materialize in many different ways in different contexts and practices. For instance, in the Veenkoloniën farming

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system the resilience principle of 'diversity' appeared as multifunctional farming and cooperation between arable and dairy farmers, but also as husband/wife co-entrepreneurship. Therefore, to fully exploit the resilience framework researchers must use it as a heuristic that allows them to find unexpected forms and factors of resilience and to develop theory through the encounter with the empirical practices, instead of applying a fixed-set of variables to shoe-horned cases.

3.7 ADAPTIVE CYCLES AND FUTURE STRATEGIES

Based on information derived using different methods, it can be argued in which phase of the adaptive cycle (Gunderson and Holling, 2002) the farming system currently is. The four phases include: growth (or exploitation), conservation, collapse (or decline/release), and reorganization (Figure 3.3). SURE-Farm distinguishes four main processes, and these processes can be in different phases of the adaptive cycle. Risk management has been investigated in WP2, farm demographics in WP3, governance in WP4 and agricultural production in WP5. The adaptive cycle is used as a boundary object to discuss about the resilience of the system. An iterative and dialogical interpretation process (Wagenaar, 2011) among researchers was applied to determine the position on the adaptive cycle. It is often difficult to objectively assess the place of the farming system on the adaptive cycles of the different processes and the system as a whole, and therefore assessments should not be interpreted as a given, but as a starting point for discussions, amongst others with stakeholders in the second phase of the SURE-Farm project.

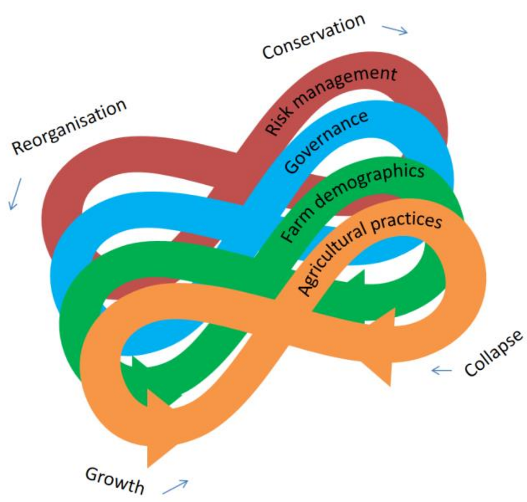

Figure 3.3. Adaptive cycles in agriculture (based on Gunderson and Holling, 2002).

Placing the position of the farming system case studies on the adaptive cycle with regard to processes and the farming system as a whole, allows for cross-case-study-comparisons. In addition, as different strategies are needed to improve resilience in different phases, an evaluation of the farming system in the context of the adaptive cycle allows a basis for designing strategies. Strategies that are considered to improve resilience in the future are also assessed for each process (risk management, farm demographics, governance and agricultural production).

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4 CASE STUDY FRANCE

Francesco Accatino

4.1 ABSTRACT

We applied the framework developed in the SURE-Farm project (Meuwissen et al., 2019) for assessing the resilience of the Bourbonnais farming system (French case study in SURE-Farm; Figure 4.1). The farming system consists mainly of extensive beef-cattle system rearing cattle on grassland for national consumption (female cattle) and for export (male cattle are mostly exported to Italy). Challenges, functions, resilience capacities and resilience attributes were assessed via a series of surveys, interviews, workshop, focus groups, implemented with farmers or stakeholders of the farming system and other assessments based on data. Challenges were mostly related to increasing frequency of droughts, low profitability, difficulty to find successors for current farmers, and public distrust of farming practices. Well-performing functions are mostly related to food production (quantity and quality) as well as natural resources, habitat quality and animal welfare, denoting a system with a good level of coupling with the natural capital. Badly-performing functions are those related to economic viability and quality of life. For assessing resilience capacity, implemented strategies were analyzed. The main implemented strategies enhance robustness and are related to the promotion of regional food self-sufficiency, via technology for storing feed in case of droughts; strategies to prevent debts via insurance and financing schemes; diversification of buyers and production for fighting price volatility. Less implemented and less concrete strategies enhance adaptability and are mostly related to the role of cooperatives that promote exchanges among farmers. Concerning resilience attributes, the system shows a moderate to high diversity (in forms of production, added values in food quality and buyers), a low to moderate modularity, a moderate level of system reserves, tightness of feedback and openness. In the adaptive cycle, we argue that the system is in the reorganization phase for risk management (as it was already exposed to risk and many strategies are being put in place), in the conservation phase for governance (as policy is quite inflexible), in the collapse phase for demographics (indeed the farming system has problems in designing farmers successors) and both in the conservation and in the reorganization phase for agricultural productions (as some farmers are more innovative and others are more attached to tradition). Workshops and focus groups performed in the Bourbonnais highlighted strategies that are desirable for the future. These strategies are mostly related to the enhancement of adaptability (and in some case would constitute, to some extent, a transformation of the system), via promoting a better coordination between actors of the value chain, a better professionalization of the workforce, the building of a positive image of the Bourbonnais, and policymakers better engaged in supporting farmers.

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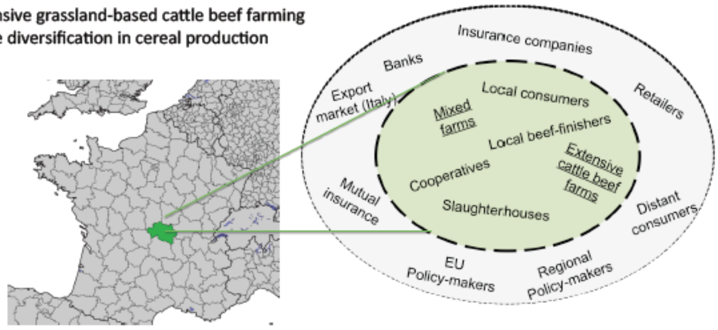
Farming system

Bourbonnais (FR)

Extensive grassland-based cattle beef farming
Some diversification in cereal production



Challenges

Institutional:

- Constantly changing policy regulations
- Excessively complicated administrative procedures;

Environmental:

- Droughts;
- Cattle diseases;

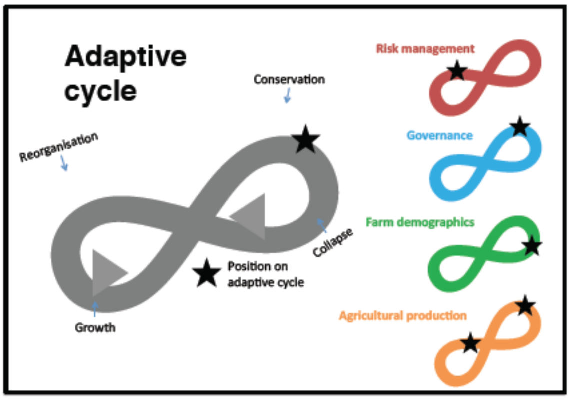
Economic:

- Low profitability;
- Farmers are weak actors in the value chain
- Opening of foreign markets

Social:

- Public distrust about beef cattle farming
- Demographic challenges

Adaptive cycle



Essential functions

Private goods:

- Food production in terms of quantity and quality: Good performance

Public goods:

- Natural resources and habitat quality: Good performance
- Animal welfare: *Good performance*

Need more attention

! Economic viability and farm income: *low performance*
Quality of life and of work: *low to medium performance*

Resilience capacities

Mainly focused on robustness and (to a lower extent) adaptability

ROBUSTNESS: diversification of productions to secure income, different ways of preventing debts, feed storage to mitigate drought consequences

ADAPTABILITY: Contacts between farmers and learning facilitated by cooperatives and farmers organisations

TRANSFORMABILITY: mainly fostered by the public distrust, but overall poor

Resilience attributes

Diversity: Moderate to high	+	Diversity of forms of production, added value, buyers
	−	Policy inflexible and does not account for specific cases
Modularity: Low to moderate	+	Complementarity between vegetal and animal resources
	−	Value chain actors are not coordinated
System reserves: Moderate	+	Coupled with the natural capital
	+	Construction of feed reserves
	−	Difficulty to find employees and design successors
Tightness of feedbacks: Moderate	+	Presence of cooperatives and farmers organizations
	−	Some actors in the value chain are not close to farmers problems
Openness: moderate	+	Sometimes mind-openness and willingness to experiment
	−	Low importance assigned to attractiveness of the area
	−	Sometimes strong willingness to transmit the farm only to family members

Future strategies

Risk management

- Promoting communication and contacts among farmers and other actors
- Promoting forms of contractualization
- Feed storage

Governance

- Facilitate the access of farmers to public market
- Being closer to farmers' needs
- Commit in developing a better tax policy

Farm demographics

- Professionalize the workforce
- Facilitate the installation of new farmers (economic help)
- Improve work conditions

Agricultural production

- Invest on quality (already doing)
- Production diversification
- Better coordination among actors of the value chain and fairer definition of prices
- Promote a better image of the Bourbonnais

Figure 4.1. Factsheet synthesizing the current resilience of the extensive beef production farming system in Bourbonnais.

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4.2 FARMING SYSTEM

The Bourbonnais region coincides more or less with the department of Allier, located in the central part of France. The farming system under consideration consists of extensive, grassland-based beef production system, with about 483000 ha of land dedicated to agricultural activities. The linkage between the livestock farming activity and the landscape is very solid. The landscape is dominated by grasslands with a reticulate of hedges forming the so-called *bocage Bourbonnais*. Agriculture is a dominant activity in the region, constituting 5.1% of the overall workforce of the region and it is mainly composed by the beef sector (42%), followed by the crop sector (16%) and small ruminant production (12%). The region traditionally sells the weanlings to Italian butchers (75518 weanlings were sold in 2014). Usually females are finished in the region, while some crop farms finish also the males. The Bourbonnais counts 5523 farms, among which 3102 are beef farms.

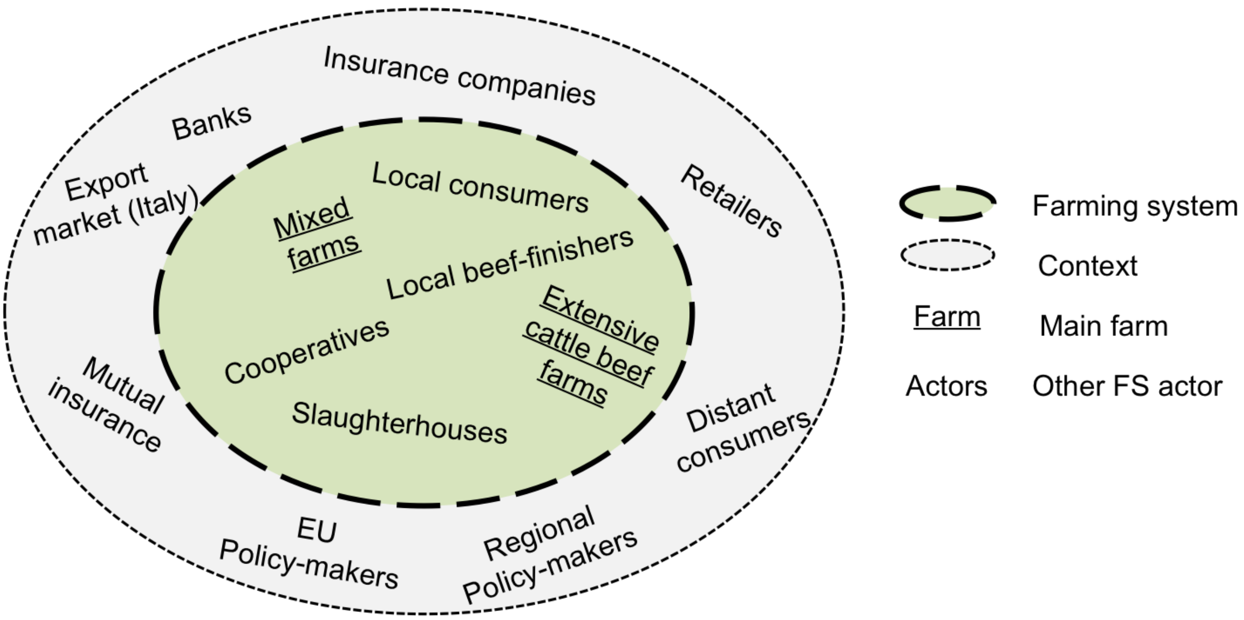

Figure 4.2. Representation of the main actors interacting in the farming system of the Bourbonnais region. The inner circle represents the actors strictly influencing and influenced by the farmers (underlined). The medium circle contains actors influencing farmers but not much influenced by them. The outer circle contains actors indirectly influencing farmers.

A non-exhausting set of actors involved in the farming system is depicted in Figure 4.2 (only the most important actors are considered). The inner circle represents the actors strictly interacting with farmers in the farming system. The main actors are, of course, farmers (mostly extensive cattle farmers but also mixed crop-livestock farms) having mainly strong interactions with local beef-finishers, slaughterhouses, contractors and cooperatives (or other forms of farm associations) and local consumers. The outer circle represents the actors having influence on the

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farmers, but while being in turn, not much influenced by them (asymmetrical relationship). Among these actors there are banks, insurance companies, export markets, large-scale processors, distant consumers, retailers, policy makers (European and regional) and the mutual insurance.

4.3 CHALLENGES

In the farm survey, the challenges receiving a higher score were the institutional challenges (score=5.24), followed by environmental challenges (score=5), economic (score-4.42) and social (score=4.38). The scores assigned to institutional challenges were statistically significantly different from the scores assigned to economic and social challenges, but not to environmental challenges. The scores assigned to economic and social challenges were not statistically significantly different. The challenges are analyzed in detail in the next subsections. Table 4.1 summarizes all the challenges mentioned, dividing them by category, by level (farm or farming system), and by duration (shock or long-term pressure) with the indication of the SURE-Farm activity that mentioned it. Challenges are described more in detail in the rest of the section.

Table 4.1. Summary of challenges in the Bourbonnais farming system divided by typology, by level (farm or farming systems), and by duration (shocks or long-term stresses). The row "Ranking of challenges based on the farm survey" corresponded to the results of the farm questionnaires (1 correspond to the challenge typology considered the most important and 4 corresponds to the least important). Beside each challenge a letter in superscript indicates the SURE-Farm activities that revealed the challenge, with the following coding: a, demographic interviews; b, learning capacity interviews; c, FoPIA-SURE-Farm workshop; d, Risk Management focus group; e, AgriPoliS workshop.

		Environmental	Economic	Social	Institutional
Farmers	Ranking based on farm survey	2	3	4	1
	Shocks	Droughts [a,b,c,e] Diseases [a,b]	Debts [a,b,d]		
	Long-term stresses		Low profitability and high price flucutations [a,b,c,d] Farmers are a weak part in the value chain [a,b,d]	Difficulty to find employees [a,b,d] Lack of time for farmers [b] Personal risks of accidents [a,b] Consumers' expectations [a,b,d] Difficulty in farm transmission [b,e] Confrontation with different actors in the countryside [b]	Heavy bureaucracy [a,b] Too frequent changes in CAP orientations [a]
Farming system	Shocks	DIseases [a,b]			
	Long-term stresses		Opening of foreign markets [a,b] Change in land use from grassland to cropland [b,e]	Ageing of farmers' population [e]	

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4.3.1 Environmental challenges

Droughts

Droughts constitute more and more a major problem for farmers as in the last years they increased in frequency. Droughts undermine the feed self-sufficiency of farmers, which are then forced to buy external feed, which is, in turn, subject to price increases. Droughts can have impacts on animals for many years, for example undermining the fertility of cows.

Diseases

During the demographic and learning capacity interviews, more than one interviewee declared to have had a sanitary problem almost every year ("*we are at the mercy of germs*"). This leads to economic problems due to additional costs and avoided income because of cows that are not accepted for selling. The spread of diseases is aggravated by other problems, such as the inefficiency of the diagnostic system: as some interviewees declared, it takes too much time to have the analysis done and, when they are done, the infection is already in an advanced state of spread. The spread of the diseases is not only a problem at the scale of the farm, but can be a whole epidemics at the farming system level, like in the sanitary crisis of 2015 and the sheep catharral fever for cattle. This caused disorder and closure of the market. For example, the Turkish market did not want to accept non-vaccinated cattle. Strangely enough, this challenge was mentioned only in the interviews to farmers and not in the workshops conceived at the farming system level (i.e., Risk management focus group, FoPIA-SURE-Farm workshop, AgriPoliS focus group).

4.3.2 Economic challenges

Low profitability

In general, farmers in the Bourbonnais have very low profitability due to the higher and higher prices of input (for example, in 2007 and 2008 there was an increase in prices of raw material and energy) and lower and lower price of meat. In this situations, farmers are not able to have loans from bank and not able to make investments (e.g., new buildings). The interviews revealed also a timeframe between cow sales and payment, which is deleterious to farmers. In addition to that, the prices are very fluctuant. To give an example, the 2009 dairy crisis led to big variations in meat prices. The interviews revealed that the look for profit is one of the major drivers of farmers' choices. It is furthermore to be mentioned that fluctuation in prices comprises also the variations in CAP subsidies.

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Debts

Most often, the high level of debts is what prevents starting the activity of farmers. The start of a farm implies indebting and usually loans from the banks are not granted or difficult to pay back. Such a challenge was mentioned by many interviewees and was also discussed in the Risk Management focus group.

Farmers are a weak part in the value chain

The interviews and the Risk Management focus groups highlighted that farmers are weak actors in the value chain. The whole value chain is not supportive to farmers' work and farmers passively get the consequences of the behaviors of buyers, feed and machinery sellers, and final consumers. The interviews revealed some examples, such as: sellers usually set the prices of animals; cooperatives are sometimes too big and lose contacts with farmers; other actors in the supply chain are not often eager to support initiatives promoted by farmers; consumers either consume less meat or prefer to buy cheaper lower-quality meat; slaughterhouses classify meat and have the power of deciding the price, therefore farmers have to adapt the practices in order to meet standards; the presence or absence of operators in the territory makes a big difference to farmers. The Risk Management focus group stressed on the lack of communication among actors in the value chain, a factor that prevents the development of a complete value chain locally, from produced to consumer, in the Bourbonnais.

Opening of the foreign market

It is difficult for farmers in the Bourbonnais to compete with farmers of other countries subject to less restrictive regulations and lower input prices. Many interviewees declared to be scared about the opening of markets and to the MERCUSOR, which would bring to an unfair competition and different balances between productions and prices.

Change in land use from grassland to cropland

Cultivating crops is certainly more profitable and less physically exhausting, which is why more and more farmers decide to invest in this activity. We classify this as a challenge as this process undermines the identity of the Bourbonnais, which historically consists of extensive beef cattle systems sustaining a very characteristics territory of grasslands and hedges. The conversion of land from grassland to crops corresponds to a strategy implemented by farmers to face economic uncertainties and for achieving feed self-sufficiency (this will be more discussed in the strategies section).

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4.3.3 Social challenges

Difficulty to find employees

Many times farmers are in the necessity of hiring people, because they have insufficient workforce to perform all the tasks related to farming activity (some farmers are even alone in the farm). However, when family members are not present or available, hiring persons is difficult. The first reason is the low wages that farmers can offer. Secondly, not many people are willing to be hired as dependent workers, because of the low attractiveness of the profession, the lack of transparency (they do not know what the farmer is deciding, especially in the context of an uncertain economy), and because young people are usually formed to be the head of the farm. The possibility to hire a person in apprenticeship discourages many farmers as it implies big responsibilities on the person hired and a lot of paperwork.

Lack of time

A certain number of respondents to the interviews mentioned the lack of time as a challenge of farmers, which is indeed strictly correlated with the challenge "difficulty to find employees". Farmers do not have enough time to dedicate to all the aspects of the farm, especially if they have also off-farm responsibilities and if plots are distant. This implies that farmers also do not have time to read and be updated about possible new solutions and practices.

Personal risks

Cow farming is essentially a risky profession. Firstly, because cows are big animals that might cause injuries and, secondly, because they are vectors of pathogens. The profession is tiring and can cause accidents, for example during lack of concentration while driving. This constitutes one of the main reasons for the lack of attractiveness of this work. In addition, subsidies and insurances do not always entirely cover a replacement in case of farmer's injuries.

Consumers' behavior

Cow farming is more and more subject to the consequences of the behaviors of consumers. Firstly, consumers simply changed their consumption choices: they buy less and less meat, or they opt for less expensive, lower quality and non-local meat. Secondly, the social consideration about beef farming is getting more and more challenging: the vegan movement was mentioned in the interviews as having a strong and negative influence on the consideration of society about cow farming in the Bourbonnais (on themes such as animal welfare and greenhouse gas emissions). What emerged in the interviews is that there is an increasing gap between society and farmers. In particular, consumers do not have a clear idea of how a farmer life is and how the farm activity

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looks like. Strong opinions expressed by consumers, amplified by social media, might also cause demotivation and depression among farmers. The Risk Management focus group highlighted the contradicting behavior of consumers that on the one hand question practices of French farmers and on the other hand are not willing to pay higher prices for good-quality labeled French beef. It is important to mention that the consumers referred to this challenge are those living outside the Bourbonnais, having a distorted vision of the farming system. Indeed, the local residents were mentioned to value the territory, especially because they are aware of how cattle farming values and sustains the territory with its aesthetic qualities.

Difficulty in farm transmission (demographic challenge)

The difficulty in designing a successor in the farm is mostly due to the fact that beef farming is not attractive. Although there are some conditions facilitating the transmission of the farm within the family, there are still problems to find people that want to take over the farm. The result is that farms are decreasing in number (from 2000 to 2010 the number of farms decreased with 25% percent and the trend is still ongoing) and increasing in surface (as highlighted in the AgriPoliS workshop). The barrier for family members is mostly the lack of attractiveness of farming and the increased facility of changing job, which allows farmers' kids to find another job instead of farming. The barrier for non-family members that want to start the farming activity is related to the lack of accessibility in terms of economic possibilities (see the challenge "Debts").

Confrontation with different uses in the countryside

Some interviews mentioned that in similar cases conflicts might arise with other residents in the territory. Some activities related to beef farming might create discomfort to neighbor residents, for example crop treatment, odors or dust.

Ageing of the farmers population

This challenge is closely related to the challenge "Difficulty of transmission (demographic challenge)". It was deeply discussed during the AgriPoliS workshop. Indeed, ageing of the farmers' population is related to the difficulty of finding successors and to the policy choices of the agricultural policymakers in the 90s, which encouraged the start of a big number of farming activities and started a "baby boom" effect. In these years there are no successors for all these farmers. The attachment of farmers to their land and cattle is not to be underestimated.

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4.3.4 Institutional challenges

Heavy bureaucracy

Many interviewees mentioned that administrative paperwork is excessively complicated. One declaration was "*When I arrived in France, I signed more papers than in the rest of my life*". A complicated paperwork makes it difficult and discouraging to request for aid or for subsidies. Furthermore, it is quite easy to make mistakes, which can result in withdrawal of subsidies.

CAP dependency

Farmers in the Bourbonnais are strongly linked to the CAP policy, at the extent that changes in CAP orientations might result in radical changes in farmers' practices. In addition, learning capacity interviews highlighted that CAP regulations are not always easy to follow and the frequent changes make it very difficult to think about long-term investments. Overall, the policy in the Bourbonnais is perceived to be quite inflexible and not so caring about particular situations.

4.4 OPPORTUNITIES

A qualitative production certified by a big amount of farms under quality labels

In the Bourbonnais, 1472 farms are currently producing under one label. The presence of a label is a strong asset for a meat producer, especially in the context of arising social concerns about meat production in France and in Europe in general. In a context of competition with foreign markets, where price can be lower due to lower input costs and less restrictive rules, being able to offer a good quality, instead of only quantity, might be a competitive advantage. This would be more effective if only consumers would be more aware of that and more willing to pay higher prices for good quality meat. Quality is certainly a big priority among farmers in the Bourbonnais. In the FoPIA-SURE-Farm workshop, participants proposed indicators related to quality in the function "Food production", denoting that quantity is not the only dimension of food production in the region. In addition, some interviewees in the demographic interviews declared that for them quality is of utmost importance (quality in the grass, in the buildings, in the welfare of animals, and in the listening of consumers' feedbacks) even if the production is not under label.

Good animal welfare

Even if a part of consumers, mostly the ones living far from the farming system, question the beef production sector in France, the Bourbonnais is characterized by a high standard of animal welfare. Animals are raised open-air and are fed on grass for the most of their lifetime. During the FoPIA-SURE-Farm workshop, animal welfare was proposed as a function of the system. However, some participants pointed out that, indeed, animal welfare is for them a normal part of the

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practices. Many farmers have emotional attachments to their animals (sometimes they even give names to their cows) and are highly careful about raising them in good conditions, with great attention to nutrition and to the prevention of diseases over the use of antibiotics. A high animal welfare is important in the context of more and more widespread questioning of practices of beef farming. In addition, higher animal welfare brings to increased production.

Grassland production fits social expectations

While some of the consumers are disconnected with the Bourbonnais farming system, not having knowledge of farmers' life, another part of consumers, more linked to the region and more aware of the farming activity highly values the whole system. Indeed, in the region, beef farming sustains a landscape of rare and typical aesthetic qualities made up of grasslands and hedges. The system is highly coupled with the natural capital, contributing to carbon sequestration and providing means of flood mitigation, erosion control and refuge for biodiversity with hedges. It is not by chance that, in the FoPIA-SURE-Farm workshop, the functions referred to habitat protection and environmental quality were highly valued and considered to perform well. The good coupling of the system to the natural capital is in itself an indicator of resilience and can indeed provide opportunities of development of other forms of economic activities, like for example the green tourism and agro-tourism (not yet well developed). It is also to be considered that the CAP (second pillar) and the local policy values the aesthetic quality of the landscape, also promoting the sanctuarization of the grasslands.

Increasing direct sale on farm

A direct consequence of the fact that local citizens value the territory and understand the linkage between aesthetic qualities of the landscape and livestock production is the increasing number of farms that do direct selling. Selling or testing products directly on farm make it possible to attract more and more people to the territory and contributes in spreading a good imagine of the Bourbonnais to a wider and wider fraction of society.

Family farm succession

In a context in which farming is less and less attractive, family farming is the most common paradigm in the region. This presents some opportunities that facilitate farm succession within the family itself. First, costs are reduced as the investment of new equipment is limited. Second, it is easier to obtain the land (while it is much more difficult to obtain and rent land from a non-family member). Third, the installation of the successor is smoother.

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4.5 FUNCTIONS

4.5.1 Importance assigned to functions

The importance assigned to functions showed an overall consistency between the farm and the farming system level, but with some fundamental differences (Figure 4.3). The most important functions at both levels were "Food production" and "Economic viability/Farm income" However, at the farm level, "Farm income" ranked at the first place, and "Food production" at the second place; on the contrary, at the farming system level, "Food production" ranked at the first place and "Economic viability" ranked at the second place. This shows that the primary goal of the farmer is the income, whereas, when we the whole farming system and the point of view of other stakeholders are considered, "Food production" becomes the most important feature and "Economic viability" is less important, being not so different from other functions, such as "Quality of life", "Natural Resources" and "Biodiversity and habitat quality".

A very big difference is observed in "Quality of life/Work conditions". Whereas at the farming system level "Quality of life" is considered of high importance, strangely enough, at the farm level "Work conditions" was assigned poor importance. We consider this result difficult to explain; possible explanations are that respondents to the survey probably considered "Work conditions" as part of "Farm income".

Concerning "Natural resources" and "Habitat quality", importance assigned was higher at the farming system than at the farm level, but in both cases it had a good rank. The higher performance at the farming system level is explained by the fact that landscape and habitat have more relevance when the system is considered in its whole and because of the presence of stakeholders in NGOs and in conservation. Concerning "Animal Welfare", we remark that for farmers in the Bourbonnais, it is part of normal practices and not really considered as a function.

Both at the farm and farming system level, the least important function were "Other bio-based resources" and "Attractiveness of the area". Indeed the main vocation of the territory is beef production and there is very small room for other non-food related productions (except for some recent development of wood production from hedges). Concerning "Attractiveness of the area" the low importance shows that actors give priority to the quality of life of local people without being interested in attracting people from outside. This is quite in contrast with the potential of the area to develop green tourism and to some strategies suggested in the FoPIA-SURE-Farm workshop related to the need of building and promoting a positive image of the Bourbonnais.

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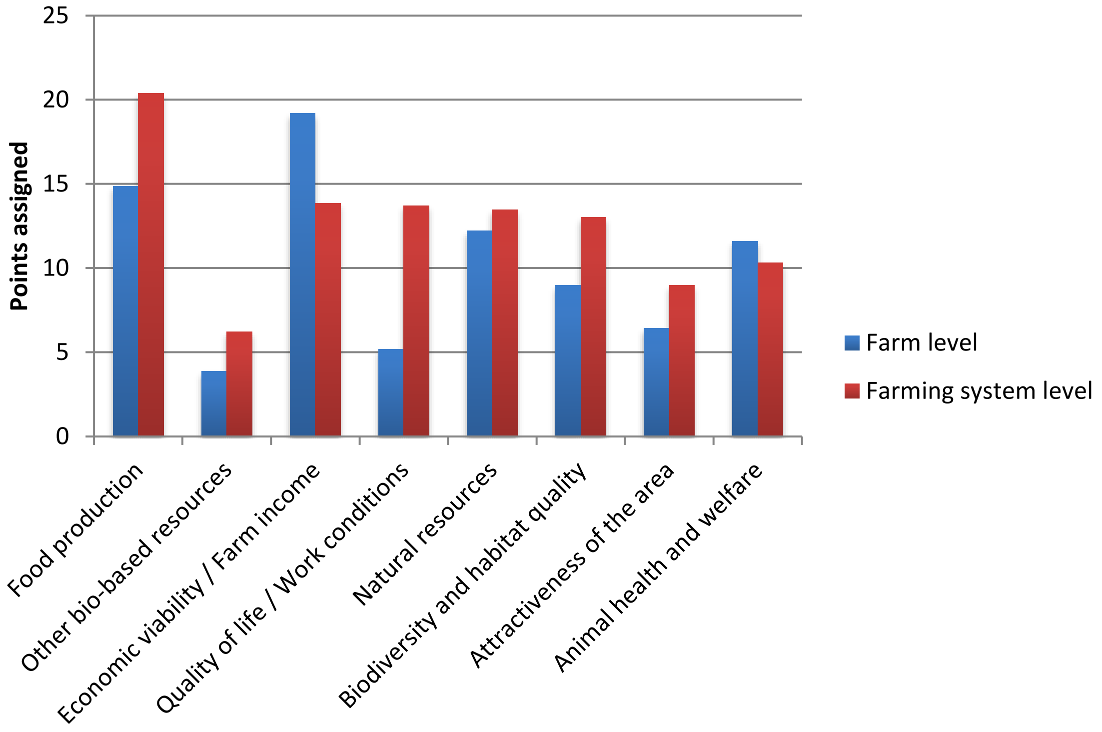

Figure 4.3. Importance of functions in the Bourbonnais region. Blue bars refer to the farm level and were assessed with farmers questionnaires, red bars refer to the farming system level and were assessed during the FoPIA-SURE-Farm workshop.

4.5.2 Performance of functions

4.5.2.1 Farm level

No assessment on function performance was assessed at the farm level (farm surveys did not include that), however, some clues could be spotted in the demographic and learning capacity interviews. Overall, what emerged is that "Food production" is well performing, in both terms of quality and quantity. "Farm income" and profitability in general is very low. Farmers pointed out that meat price is too low and expenses increase. Many farmers are no longer able to live decently and to invest in new buildings or in equipment. Lack of profitability is one of the main reasons for quitting the farm. "Animal welfare" was undoubtedly well performing as farmers did not hesitate to point out how the wellness of their animals is of utmost importance for them, showing even emotional attachment. Farmers were well aware about the good performance of natural resources, as they mentioned that they could not imagine their farming activity dis-coupled from the natural environment. Other functions were not explicitly mentioned.

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4.5.2.2 Farming system level

Performance of functions was assigned on a scale from 1 to 5 (Figure 4.4). The most well performing functions at the farming system level were "Animal Welfare" and "Food production". The very good performance of animal welfare is coherent with many interviews in which respondents showed attachment to their animals and to the fact that the extensive cattle rearing in the Bourbonnais promotes animal welfare, animals are fed on grass and stay open-air for almost all their lifetime. Concerning "Food production", FoPIA-SURE-Farm participants had no doubts and no disagreement in assigning a high score, as it is the real main vocation of the territory. It is, in addition, to be noted that, according to the participants, it is not only about quantity but also about quality and self-sufficiency.

"Natural resources" and "Habitat quality" performed relatively well, confirming the linkage of the production system to the natural capital and, importantly, that people in the Bourbonnais are aware of that. The system is in fact very related to grasslands and has very good recycling of nutrients. This is also improved by the presence of crop farmers that are complementary to cattle farmers. As expected by the analysis of the challenges, "Economic viability"/"Farm income" had low performance, and this is quite remarkable as this function is assigned very high importance.

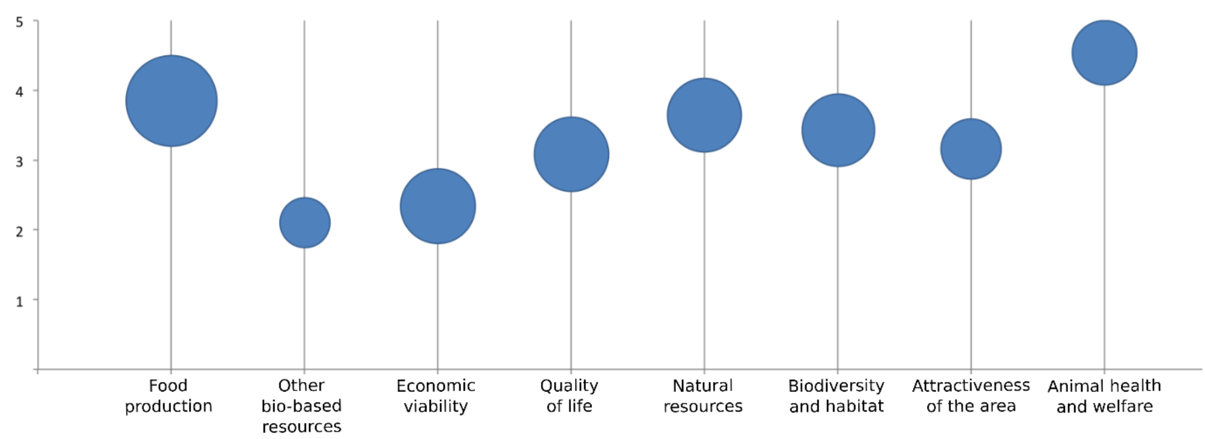

Figure 4.4. Performance (vertical position of the circle) and importance (radius of the circle) of functions at the farming system level, assessed during the FoPIA-SURE-Farm workshop.

4.5.3 Ecosystem services assessment

The deliveries of private and public goods from in the farming system calculated in the ES assessment are depicted in Figure 4.5 and Figure 4.6 respectively. In the box plots, the comparisons with the performances in the rest of the region are depicted. By comparing the

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delivery of functions in the farming system with the rest of the region it is possible to understand if the farming system plays a role in increasing or decreasing the function in the region.

Concerning private goods (Figure 4.5), it is not surprising that the farming system performs badly in all of them, because the animal production, which is the main production of the Bourbonnais, is not represented it was not part of the JRC date used for this analysis. The fodder production is quite low comparing to the rest of the region, as it is only slightly developed in the farming system that remains based on grassland. Crop production, on the contrary, is slightly higher than the rest of the region, and this could be explained by the strategies of production diversification implemented by farmers. The energy production is slightly higher compared to the rest of the region, probably because of the presence of hedges. Despite the Bourbonnais is based on grazing cattle, the density of grazing cattle is quite low (see the normalized representation in the flower diagram). This could be explained by the fact that the system is very extensive and despite the cattle heads are in high number, they are dispersed in a wide surface. Timber removal is quite low because the farming system is based on grassland and there are forests in another part of the region.

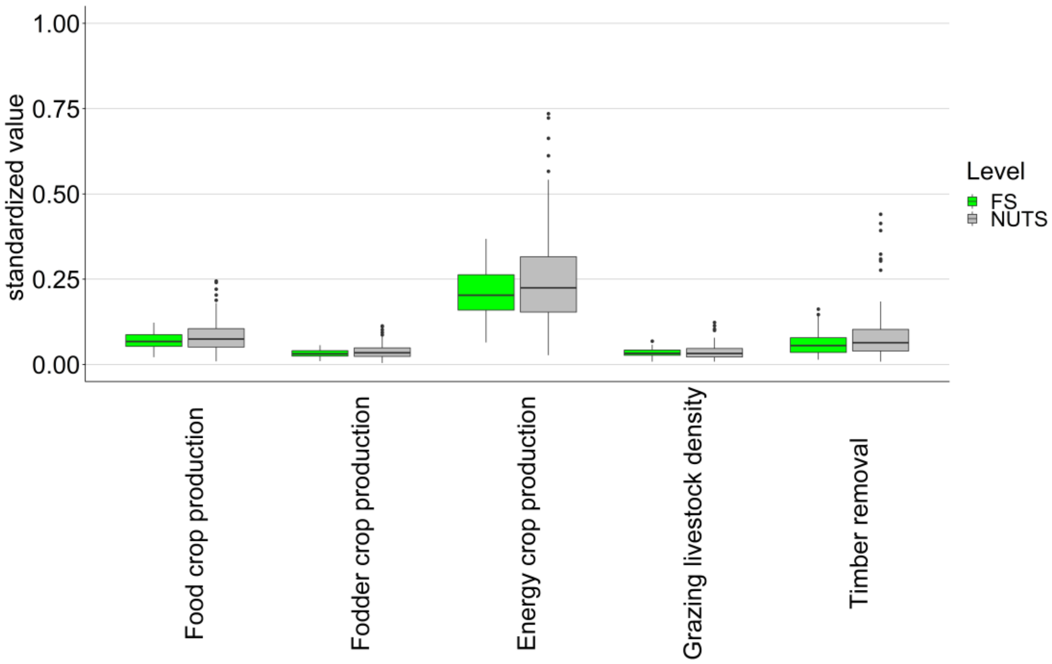

Figure 4.5. Delivery of private goods in the Bourbonnais farming system case study. The boxplots represent the variability of the standardized proxies of private goods within the 10km-x-10km squares composing the farming system (green boxes) and the variability of the standardized proxies of private goods within the 10km-x-10km composing the NUTS3 region(s) in which the farming system is contained (grey boxes).

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Concerning public goods (Figure 4.6), the performance is lower than the rest of the region for bird habitat quality, pollination, recreation, and NO_x retention capacity. We overall agree about bird habitat quality, pollination, carbon storage, and NO_x retention capacity. In fact, bird habitat quality and pollination can be higher in a mixed agricultural and forested landscape, which is not always the case in open grasslands; carbon storage remains low in grassland as there is a very fast cycling of organic carbon (contrary to forest).Therefore, while the sequestration of carbon (flux) is high in grassland, the storage of carbon remains low. NO_x retention capacity is higher in forests than in grasslands. We do not agree about the performance assigned to recreation. Indeed, the Bourbonnais has a very typical landscape which is even valued and protected by public policies (sanctuarization of the grassland). Furthermore, workshops, focus groups and interviews confirmed the beauty of the landscape and the importance of valuing it in the future. Capacity to avoid soil erosion is slightly higher than the rest of the region, and this is due to the grassland and the presence of hedges that protect soil from erosion. Finally, water concentration index, equilibrium phosphorous concentration, and organic matter in topsoil concentration, do not show a significant difference with the rest of the region.

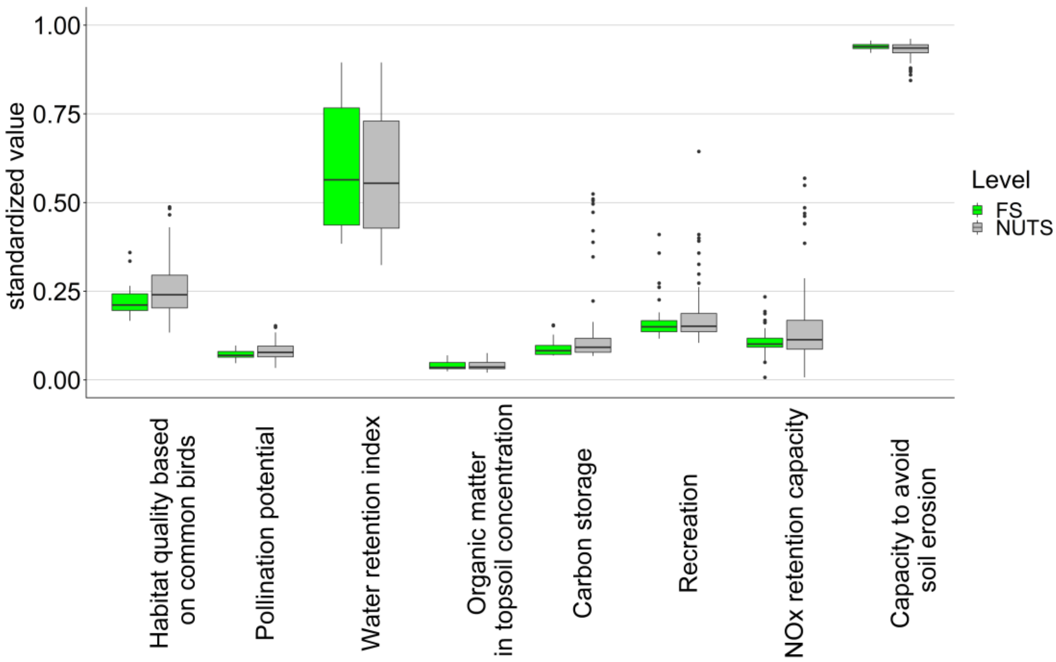

Figure 4.6. Delivery of public goods in the Bourbonnais farming system case study. The boxplots represent the variability of the standardized proxies of public goods within the 10km-x-10km squares composing the farming system (green boxes) and the variability of the standardized proxies of public goods within the 10km-x-10km composing the NUTS3 region(s) in which the farming system is contained (grey boxes).

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4.6 RESILIENCE CAPACITIES

The replies given to the farm survey to questions about resilience capacities, i.e., robustness, adaptability, and transformability (boxplot shown in Figure 4.7) revealed an average score (on a scale from 1 to 7) of 4.20 for robustness, of 4.29 for adaptability, and of 4.31 for transformability. This section provides the list of the strategies along with a description. The level of implementation is not the same for each strategy.

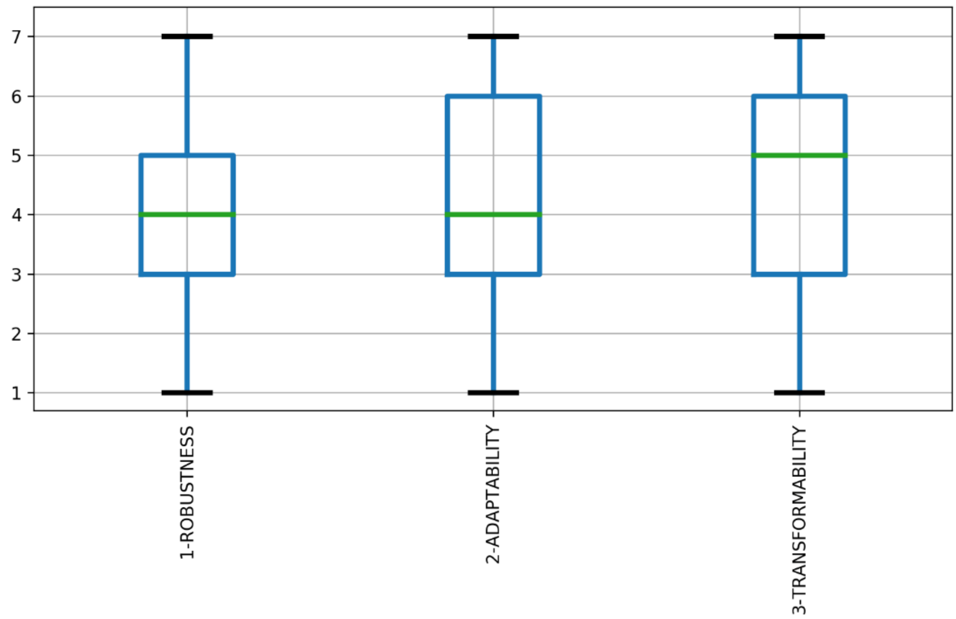

Figure 4.7. Boxplot representing the answers (given as scores from 1 to 7, only integer numbers) to the farm survey related to the resilience capacities, i.e., robustness, adaptability, and transformability

4.6.1 Contribution of policy to resilience capacities

The analyses of the agricultural policies (CAP, National and regional policy) with the ResAT wheel (Figure 4.8) revealed policy goals and instruments mostly focused on promoting robustness, to a less extent adaptability and very poorly transformability.

A clear priority is assigned to the goals and to the implementation of tools in the short-term rather than in the medium or long term, promoting strategies for gaining immediate general efficiency. Measures focus more on the stabilization of acquired situations. Some goals are stated and some instruments are implemented in the medium term, in order to facilitate collective actions. One of these instruments is the LEADER program, which is actually not very accessible by the majority of farmers and results therefore in a program for an “elite”. Also the GIEE program, aimed at promoting collective actions in the medium and long term, results applied by a minority of farmers. Also the greening measures are focused more on avoiding degradation than in promoting

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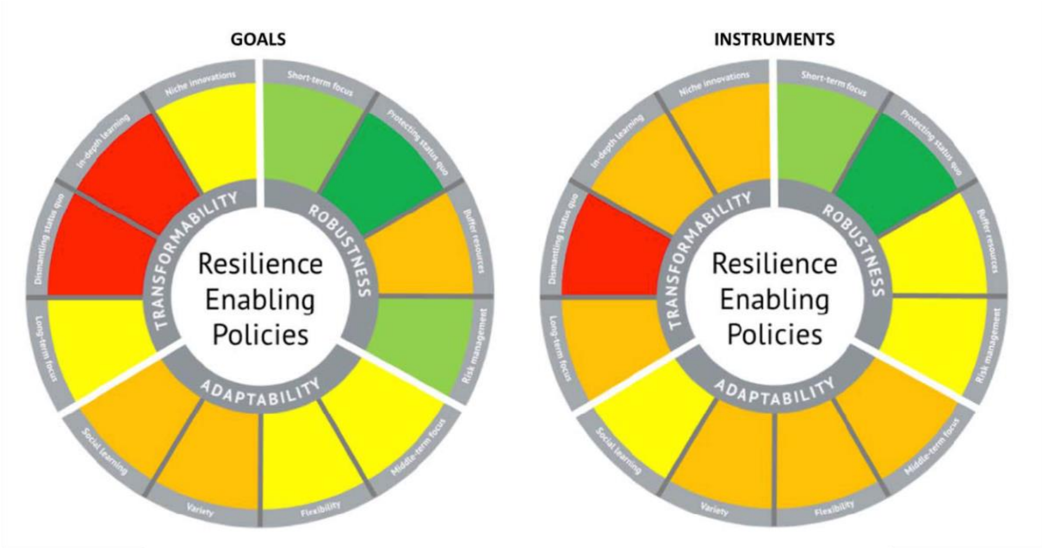
an ecological transition. In this context, a medium term declared objective by the 2014 law is to bring French agriculture to the transition to the triple objective of good economic, social, and environmental performance. Concerning the long term, it is true that a vision in the French agricultural policies is to recognize agriculture as the main vocation of the country, however, such a vision remains poor of practical implementations and although some weak signs of long-term changes are present, the business-as-usual logic remain predominant.



Question: To what extent do the policy's goals and instruments enable or constrain the characteristic?		
Answers: enabling	**Answers: constraining**	**Score (+ colour)**
Not clear		**0** (White)
Not enabling	Very constraining	**1** (Red)
Slightly enabling	Constraining	**2** (Orange)
Fairly enabling	Fairly constraining	**3** (Yellow)
Enabling	Slightly constraining	**4** (Light green)
Very enabling	Not constraining	**5** (Dark green)

Figure 4.8. The ResAT wheel applied for the extensive beef cattle production in the Bourbonnais region. The attributes are the key characteristics for resilience-enhancing policies. The given color indicate to what extent the key characteristic is enhancing or constraining the resilience capacity.

The *status quo* is clearly protected both by policy goals and instruments. The coupled payments are supported, as well as schemes for the support of the least favored areas. The regional development program does not support labelling and quality sector, therefore not promoting the participation of farmers to more profitable markets. Flexibility is not explicitly encouraged by policy goals but at the same time not constrained. However, policy instruments seem to increase the rigidity of the system: an example is the derogation from crop diversity rules for green payments in case of maize monoculture. The implementation of the few flexibility instruments is hampered by the huge amount of administrative rules.

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Concerning risk management, the second pillar and the national program specifically encourage risk management with crop insurance assistance and the support for health and environmental mutual funds. However, the implementation of these risk management goals still relies on European guidelines and is not very well implemented in the study region.

Concerning measures of adaptation to the local context, the second pillar offers some potential but it is not very well implemented by the regional administrations and by local leaders. Instruments remain very generic and not suitable for tailored solutions. Collective learning is very minor (if not absent) in the declared objectives of the French agricultural policies. Such a function is mainly delegated to technical and economic advisors. Instruments are not at all focused in the deconstruction of old roads and routines.

4.6.2 Strategies implemented at the farm level

Present and past strategies mentioned in the different SURE-Farm activities at the farm and farming system level are organized in Table 4.2 and Table 4.3, respectively, along with their contribution to the different resilience capacities.

Achieve feed self-sufficiency

Achieving feed self-sufficiency is mainly meant as a strategy for feeding animals despite droughts or floods, without buying external food. It is thus a strategy to respond to the challenge of "Droughts" and "Debts" or "Low profitability and high price fluctuation". Learning capacity interviews revealed that some farmers use to store cereals and protein crops in silo if they are running low in grass availability and do not hesitate to adapt their cows' ration to available food, in order to avoid purchasing off-farm feed. A sub-strategy consists in investing in new practices and technologies for achieving feed self-sufficiency, mostly related to building for feed storage.

Diversification of the production

Learning capacity and demographic interviews revealed that the diversification of the production is one of the strategies most adopted by farmers in order to face economic and environmental challenges (e.g., "Droughts" and "Low profitability and high price fluctuation"). In this sense, a farmer can secure an income in face of uncertain market and has always a form of production to rely on. In some cases, diversification means shifting, in a certain measure, from animal production to cereal production, which is less demanding, more profitable, and less subject to price fluctuation. At the scale of the farming system, this leads to an erosion of the main identity of the Bourbonnais, which is indeed characterized by grassland-based extensive beef production, creating a landscape of highly appreciable aesthetical qualities. Therefore, the conversion of grassland to cropland is classified as a challenge at the farming system level. Last but not least,

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diversification also means converting a part of the productions to crop that satisfy consumers' expectation. Learning capacity interviews revealed the development of protein crops (mainly lentils).

Diversification of buyers

Diversifying the buyers is a strategy for guaranteeing a stable income and face the challenge "Low profitability and high price fluctuation".

Join a farm organization, cooperative, collective farming

Joining a farm organization is a way for farmers to be more supported in the value chain, avoid or soften debts and getting some practical help in the various tasks. Both demographic interviews and learning capacity interviews highlighted that collective farming brings the following benefits: avoiding investing in expensive material and machinery, as it can be shared with other farmers (response to the challenge "Debts"); getting higher weight and importance with other actors of the value chain, being part of a structure that protects single farmers and has a better negotiation power (response to the challenge "Farmers are a weak part in the value chain"); being facilitated in the sale process, as cooperatives do a good job in linking producers and buyers with a greater power in negotiating prices than single farmers (response to the challenge "Farmers are a weak part in the value chain"); having the possibility to offer and receive help in case of illness, injuries or for going on holiday (response to the challenges "Lack of time" and "personal risks of accidents"). It is to be pointed out that, according to some interviews, there are farmers that prefer staying on their own taking full responsibility of their own decisions. In addition, when cooperatives grow too big, they lose the capability to be close to farmers' needs.

Hiring workers

Hiring workers was a strategy implemented by some respondents, in order to have a better life quality at work (response to the challenge "Lack of time"). However, as listed in the challenges, the AgriPoliS workshop pointed out the difficulty of finding workers to hire.

Investing in new technologies and practices

Technology is meant to be a way to improve labor quality of farmers (challenge "Lack of time"), for example cameras or collars. However, some respondents specified that technology can complicate things in case it does not work (e.g., "*cameras are very useful… when they work!*"). In some cases, for farmers who care mostly about environment, investment in new technologies means reducing the environmental impact of the farm. This consists, for example, in the installation of solar panels or in the installation of water purifiers.

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Prevention of diseases

More respondents stated that they implemented some vaccination with the help of the veterinaries in order to avoid diseases.

Mind-openness

Interviewees were aware that being open-minded is simply a way to find new strategies and solutions. This happens by reading and by speaking with others. Being open-minded also involves being open to experimentation. However, in the Risk Management focus group, participants highlighted that farmers are not always willing to step back and question their practices.

4.6.3 Strategies implemented at the farming system level

Developing farmers' associations and cooperatives

If one of the strategies at the farm level is to join a cooperative or another form of farmers associations, the development of farmers associations and cooperatives is an important strategy promoting resilience at the farming system level. The Risk Management focus group pointed out several roles played by cooperatives in the farming system of the Bourbonnais: they provide technical support to farmers; they facilitate the exchange of information between farmers and other actors in the farming system; they know the farmers, listen to their problems and provide advice to improve their life quality; they encourage, provide support and facilitate farmers in the acquisition of labels; they facilitate forms of contractualization (i.e., a way of assuring to farmers that a certain amount of their products is sold); they provide funding and financial help, especially when banks refuse to do so; they act as intermediate between farmers and sellers, helping in the definition of fairer prices and strengthening the position of farmers in the value chain. In general, the Risk Management focus group highlighted a strongly positive role of cooperatives in the Bourbonnais, recalling episodes in the past when cooperatives were fundamental for farmers. However, cooperatives still have a margin of improvement, for example they should promote a better coordination with other actors in the value chain.

Facilitating young farmers installation

The FoPIA-SURE-Farm workshop mentioned this strategy. It consists in promoting ergonomics, work organization, and bank support. Such a strategy is definitely important for the demographic challenge (lack of turnover). In reality, given all the problems pointed out in the demographic interview and in the AgriPoliS workshop, we would say that this strategy is not still well implemented in its full but it can be considered a good aim for the future.

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Professionalize the workforce

This strategy, mentioned in the FoPIA-SURE-Farm workshop, consists in improving the training for farmers as well as potential future farmers and in a major recognition of the employees job. Also for this strategy, we would say that it is not quite developed, given the insights from the demographic interview, learning capacity interviews, and the AgriPoliS workshop, that highlighted a lack of attractiveness of the farmers' work and a difficulty to find new employees.

Improving food and feed self sufficiency

This strategy consists in a series of sub-strategies aimed at improving the overall self-sufficiency of the region, and was explicitly mentioned in the Risk Management focus group. In the FoPIA-SURE-Farm workshop, the participants highlighted the importance of producing food in a self-sufficient manner (self-sufficiency was proposed as an indicator of food production). Even though food and feed self- sufficiency are separated concepts, the participants of the focus group did not really separated them, referring mostly to the concept of self-sufficiency of the region. The notion of feed self-sufficiency refers to the ability of farmers to rely on their own resources in face of climate challenges without buying external feed. Food self-sufficiency corresponds to the ability of the farming system level to close the value chain within the territory, encouraging also the consumption of local food by local consumers and with some policy interventions, for example promoting the consumption of local products in the school canteens. The participants of the focus group highlighted a lack of performance by most of the actors in this strategy, except for an average performance of farmers (score of 2.5 out of 5) of farmers in adopting new technologies and practices. However, there is a long way to go, especially by consumers (they should be willing to pay higher prices for local and high quality food) and by policy-makers that were considered quite far from farmers' needs. Overall there should be a greater coordination within the value chain.

Promoting innovations in technologies and practices

This strategy is contained in the previous strategy "Improving food and feed self-sufficiency" and regards the part related to the adoption of new technologies. Farmers were considered moderately open to that, even though the Risk Management focus group pointed out that they are often reluctant to step back and question their own practices.

Developing grass fattening

Grass fattening makes it possible to close the value chain in the territory, without rely the selling of young calves for export. This strategy would make entire use of the extended grassland resources present in the region, contrasting the drift to cereal cultivation. During the FoPIA-SURE-

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Farm workshop, this practice was mentioned as of very recent development (present strategy) that can be possibly be more widespread in the future. However, such a practice would make farmers less robust to climate fluctuations.

Adopting practices that mitigate floods

This strategy was mentioned in the FoPIA-SURE-Farm workshop. If droughts are mitigated by prevention (technologies and strategies that make it possible to avoid the consequences of droughts, like storage of feed), the excess of water should be mitigated with hydraulic constructions (e.g., draining ditches) or ecological engineering (most of all the maintenance of hedges).

Adopting practices that fulfill social expectations

This strategy consists of adopting a series of impacts that reduce environmental impact of beef farming and improving animal welfare, two topics on which society is more and more demanding. In the FoPIA-SURE-Farm workshop, it was mentioned that animal welfare is very highly considered in the Bourbonnais and farmers truly believe that their practices are very respectful to animals, as for example they spend a lot of their time on grass. Also the demographic interviews and the learning capacity interviews revealed a very high attachment of farmers to their animals. From the farmers' side, the FoPIA-SURE-Farm workshop mentioned that what can be done is the improvement of the conditions of the slaughterhouses. However, even though farmers try to improve their practices, what is necessary is a better consideration of farmers by consumers, a better organization of the system to provide support to farmers in sustaining more expensive production costs and, above all, a willingness to pay higher prices by retailers and consumers. The FoPIA-SURE-Farm workshop mentioned the need of building a "positive image of the Bourbonnais" but a big part of responsibility is on policy, consumers, cooperatives and other actors of the value chain that are not considered to do enough.

Debt limitation

This strategy is intended to face directly economic challenges "Debts" and "Low profitability and high price fluctuation" and more indirectly other challenges, mainly environmental (e.g., "Droughts") and demographic (e.g., "Difficulty in farm transmission"), that potentially cause debts. The strategy consists in a set of sub-strategies for avoiding the over-indebtedness of farmers, especially when purchasing new equipment or building and, above all, preventing farmers to committing in too risky investments (especially when starting the activity).

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Good risk assessment by banks

A strategy for contrasting debts is played by the banks by making a good risk assessment. Avoiding high risks is important in the long-term sustainment of the bank. Committing in low-risk investments is vital for farmers in need of money to start the activity and for the farming system in general. The Risk Management focus group pointed out the good performance of banks in the Bourbonnais in this role.

Advancement of payment by cooperatives

Cooperatives were considered by the participants of the Risk Management focus group as able to provide a very good support to farmers. In particular, cooperatives can provide financial support when banks do not provide it.

Insurance

Insurance companies make it possible to avoid the consequences of shocks (for example droughts)

Contractualization

This strategy was mentioned more than one time in the Risk Management focus group, however it was pointed out not to be much developed and deserving better implementation in the future. Contractualization make it possible for farmers to secure the selling of a certain part of their production at a certain price, independently of market fluctuations.

Improving life quality at work

This strategy consists in improving the comfort of farmers by means of technological tools, reducing working hours, making it possible for farmers to take more holidays. This would make the profession more attractive in the Bourbonnais.

Facilitating exchange of information between farmers

In the Risk Management focus group, participants pointed out that exchanges between farmers are vital to promote cooperation among farmers and between farmers and other actors in the farming system; to foster social contacts and prevent isolation; and, more in general, promote the "open-mindedness" that is mentioned more than one time in the interviews. The focus group highlighted the good performance made by cooperatives in this strategy.

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Monitoring farmers' situations

It is important to monitor the different situations of the farmers in the region in order to prevent accidents, to know financial situations and farmers concerns. In general, according to the participants of the Risk Management focus group, more actors contribute well to this strategy: banks and insurance companies monitor financial situations and prevent accidents, and cooperative are considered to be well close to farmers' problems and concerns.

Insurance replacement service

This form of insurance make it possible for the farmer to have a replacing person looking after the farm in case of accident or also holidays.

Policy supports direct payments and insurance schemes

The ResAT assessment highlighted a focus of policy more on the maintenance of the *statu quo* rather than on the encouragement of innovations. In fact, policy is mainly focused on direct payment and on the support to insurance scheme. It is to be noted that, apart from this, the Risk Management focus group highlighted a very bad absence of support of policy to the needs of the farmers. Policy was even considered a challenge to farmers, with schemes that change continuously and to which farmers need to adapt.

The LEADER program

The ResAT report acknowledged the LEADER program as the only tool of policy put in place for encouraging innovation in the Bourbonnais and the networking with other rural realities. However, we have no clue from other activities in the context of SURE-Farm if this program is effectively well implemented in the region and has an impact.

Questioning practices

Even though this is more a challenge than a strategy, we decided to include it also in the list of strategy as questioning practices by consumers is indeed what triggers the change of the farming system, making the actors of the farming system more in situation of rethink themselves. This was pointed out in the Risk Management focus group and considered as a trigger for system transformability.

4.6.4 Contribution to resilience capacity, farmer and farm household

The strategies discussed at the farm level are summarized in Table 4.2 along with brief comments on their contribution to the different resilience capacities. Although results from the farm survey

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(representing a self-assessment of the resilience capacities – Figure 4.7) suggest a higher performance of transformability, overall, following our interpretation of the outcomes of the workshops and focus groups done (which include the point of view also of other actors and our points of view as researchers), the strategies are mostly focused on robustness with some, less concrete, contribution to adaptability. The most concrete and implemented strategies regard the technologies and practices put in place for storing feed for facing droughts, diversifying production and buyers to increase robustness to price changes, and join cooperatives to increase their importance in the value chain.

Forms of adaptability are in practices that are less concrete or less applied. For example, achieving feed self-sufficiency is a form of adaptation of the farm to the increasing frequency of droughts. However the more concrete implementation regard strategies to increase the robustness to single events. Adaptation to droughts corresponds to adapting cows' diet to feed availability, but this was not registered as a widely implemented practice. Hiring workers is a form of adaptation to the reality of a difficult profession but, as mentioned in the challenges, farmers have difficulties in implementing it for reasons related to the whole farming system and to the poor attractiveness of the farming profession. Preventing diseases is a form of adaptability to risks of diseases outbreaks.

Adaptability and transformability can, in some senses, be enhanced by the investment in new practices and technologies as well as in open-mindedness. However, the Risk Management focus group highlighted that farmers are only rarely willing to step back and question their own practices, in addition, technology has also some negative impacts on robustness (when it fails) and open-mindedness is not strictly a strategy, it is more an attitude.

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Table 4.2. List of strategies implemented in the Bourbonnais at the farm level along with their contribution to robustness, adaptability, and transformability. The sign (+) or (-) indicates that the strategy is well or poorly implemented in the Bourbonnais farming system, respectively. When strategies are indented (with bullet points) they represent sub-strategies of the strategy above.

STRATEGY	ROBUSTNESS	ADAPTABILITY	TRANSFORMABILITY
Achieve feed self-sufficiency (+)		This corresponds to an adaptation of the farmers' practices to external challenges, such as droughts	
Change in technical practices for feed self-sufficiency (+)	The technical practices put in place to mitigate the consequences of droughts without need of buying external feed is a form of robustness	One form of practice for achieving self-sufficiency is to adapt cows' diets to situation	
Diversification of the production (+)	Diversification makes the farm more robust to price fluctuation, being it a way to secure income from at least one form of production	Diversification is also a form of adaptation to consumer expectations	
Diversification of buyers (+)	Diversifying buyers ensures a market output in the context of price fluctuations and uncertainty in the value chain.		
Join a farm organization, cooperative, collective farming (+)	For a farmer, joining a form of collective farming constitute a buffer against difficult value chain environment	Joining a farm organization implies the adaptation of the activities to the collective rules	
Hiring workers (-)		Hiring workers is a form of adaptation in order to improve work conditions	
Investing in new technologies and practices (-)	(-) unfortunately technology can fail, making the farm more complicated and more vulnerable to failures	According to the extent of innovation of technologies and practices, this strategy can be considered a form of adaptability or transformability	According to the extent of innovation of technologies and practices, this strategy can be considered a form of adaptability or transformability
Prevention of diseases (+)		Prevention constitute a form of adaptability	
Open-mindedness (+)		This strategy, which is more an attitude, is meant to foster the capability of farmer to adapt to new situations or even to transform the farm	This strategy, which is more an attitude, is meant to foster the capability of farmer to adapt to new situations or even to transform the farm

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4.6.5 Contribution to resilience capacity: farming system

By analyzing the strategies implemented at the farming system level (Table 4.3), we argue that what is promoted in the farming system is robustness and adaptability. Robustness strategies are mostly related to face economic issues and consists of strategies by various actors to prevent debts and mitigate the consequences of negative events. Banks and cooperatives help farmers financially; forms of contractualization, although not often implemented, secure a certain income to the farmer in face of fluctuating prices; insurances help the farmers avoiding the negative consequences of droughts or other events; monitoring farmers situations increases the robustness. According to the ResAT analysis, also public policy is mainly focused on robustness and on the maintenance of the status quo.

Some strategies are indeed aimed at improving adaptability. Providing advice to farmers as well as facilitating exchanges between them makes the system more adaptable to new situations. Strategies aimed at promoting the installation and the professionalization of young farmers (although not very much implemented) are forms of adaptability of the system in face of demographic challenges. The balanced risk assessment by banks and financing of projects help the whole system to adapt to new needs.

Signs of transformability were seen in the challenging of the practices by the consumers. Indeed, questioning practices help farmers and the actors in the value chain and in the farming system to think and conceive new solutions, even though this might seriously affect the robustness of the system.

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Table 4.3. List of strategies implemented in the Bourbonnais at the farm level along with their contribution to robustness, adaptability, and transformability. The sign (+) or (-) indicates that the strategy is well or poorly implemented in the Bourbonnais farming system, respectively. When strategies are indented (with bullet points) they represent sub-strategies of the non-indented strategy above. The table continues over three pages.

STRATEGY [Actor]	ROBUSTNESS	ADAPTABILITY	TRANSFORMABILITY
Developing farmers association [Cooperatives] (+)	Cooperative and farmers associations are more robust in facing external challenges than farmers alone	Providing advice to farmers, taking advantage of the knowledge of the whole region, help the system to adapt to several type of challenges	
	By advancing payments cooperative can help buffering against debts	They help the farmers in the context of the value chain by being intermediary between supply and demand.	
	By facilitating contractualization the make the farmers activity more robust to price fluctuations	By encouraging and assisting farmers in obtaining official labels, cooperatives make the system more adaptable to social expectations	
Facilitating young farmers' installation (-)	-	Facilitating young farmers' installation smoothens the transmission of the farm, therefore adapting the farming system to continue the farming activity across generations	
• Professionalize the workforce (-)		This is a form of adaptation to make the system more adapted to get new farmers and to face demographic challenges	
Improving food and feed self-sufficiency (+)		In general this corresponds to a set of strategies that all together corresponds to an adaptation to a challenging economic and climatic context. The system is then more robust to droughts or economic shocks.	
• Promoting innovation in technologies and practices [Farmers] (+)	This strategy makes the system more robust to droughts		
• Developing grass fattening [Farmers] (-)	(-) Grass fattening would make the system more food sufficient but at the same time more dependent on grass production, therefore less robust to droughts and climatic shocks.		Developing grass fattening is indeed a transformation of the system as it corresponds to a new form of production and would create new skills and professions.

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Table 4.3. Continued

STRATEGY [Actor]	ROBUSTNESS	ADAPTABILITY	TRANSFORMABILITY
Adopting practices that mitigate floods (+)	Flood mitigation is indeed a way to increase the robustness to droughts		(-) Indeed, practices that mitigate droughts are often long-term changes of the system that constrain its transformability
Adopting practices that fulfill social expectations [Farmers] (-)		This is a set of strategy aimed at adapting the system to social expectations	
Debt limitation (+)	Limiting debts enhances the robustness of farming activities to some key events, such as the consequence of droughts or the starting of the activities		
• Good risk assessment by banks [Banks] (+)	Providing funding is a form of robustness for farmers	A balanced risk assessment by banks corresponds to a co-evolution of banks and farmers, promoting the sustainment of the first and the vitality of the second. When banks provide financing schemes to promote projects, they in fact promote changes that constitute the adaptation to a context of the system or even its transformation	
• Advancement of payment [Cooperatives] (+)	By advancing payments cooperative can help buffering against debts		
• Insurance [Insurance companies] (+)	Insurance schemes constitute a way to enhance robustness of the farms to the consequences of negative events (e.g., droughts)		
• Contractualization (+)	Contractualization makes the system more robust to price fluctuations		
Improving life quality at work (+)	In this set of strategies there are also strategies to mitigate the consequences of accidents to farmers.	This is a set of strategies aimed at adapting the farming activity by making it more attractive to non-farmers and more enjoyable for farmers	
• Facilitating exchanges of information between farmers (+) •		The circulation of information foster the adaptability of the system or even its transformation	The circulation of information foster the adaptability of the system or even its transformation
• Monitoring farmers' situations (+)	Monitoring situation of farmers can serve as a prevention of accidents and therefore enhances the robustness to consequences of negative events		

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Table 4.3. Continued

STRATEGY [Actor]	ROBUSTNESS	ADAPTABILITY	TRANSFORMABILITY
• Insurance replacement service [Insurance companies] (+)		This particular insurance scheme make the farming profession more suitable to farmers' needs, as it allows the farmer to go on holiday having someone looking after the farm	
Policy supports direct payments and insurance schemes (+)	Supporting direct payments and insurance schemes constitutes mainly a support of the status quo making the system robust to challenge but barely supporting innovation		
LEADER program for rural development promoted by EU (+)		By encouraging experiment in rural areas and promote exchange of information between rural actors, the program promotes adaptability and innovation	By encouraging experiment in rural areas and promote exchange of information between rural actors, the program promotes adaptability and innovation
Questioning practices [Consumers] (+)	(-) Despite being a trigger of transformation, consumers can seriously affect the robustness of the system by challenging it.		This is one of the major triggers of transformation of the system

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4.7 RESILIENCE ATTRIBUTES

Regarding the performance of resilience attributes (Cabell and Oelofse, 2012), a part of the FoPIA-SURE-Farm workshop was aimed at assessing their degree of presence in the Bourbonnais. However, the exercise did not provide the desired outcomes because unfortunately participants to the workshop were not very clear about the instructions and they scored the different resilience attributes in different ways. Therefore, in this section, we decide to assess the different resilience attributes by elaborating on the material collected in the various activities on the Bourbonnais. We argue that the most important attributes in the systems are: "Ecologically self-regulated", "coupled with the natural capital", "exposed to disturbance", "functional and response diversity", and "reflective and shared learning". Below more detail is given about each attribute.

Socially self-organized

At the farm level, this attribute is quite low, because in the interviews respondents highlighted a lack of time for performing all the activities and a difficulty to design a successor. At the farming system level, this resilience attributes performs better because of the presence of cooperatives and farm associations promote exchanges among farmers and between farmers and other actors. However, at the system level, there are some demographic problems that persist, due to the difficulty for farmers of finding a successor or an employee and a lack of recognition and professionalization of potential farm workers.

Ecologically self-regulated

We argue that the system performs well in this attribute, as it is an extensive beef system where nutrients are recycled and there is complementarity between crop farmers and cattle farmers. In addition, the presence of hedges is an element of ecological engineering, mitigating floods and preventing soil erosion.

Appropriately connected

At the farm level, farmers tend to join farmers associations and to be connected with some other farmers in order to discuss practices and possible solutions. Concerning other actors, the Risk Management focus group highlighted that different actors (except cooperatives) are not very close to farmers and do not know their problems and situations. In particular the Social Insurance should do more in order to connect to farmers.

At the farming system level, we inferred a lack of connection between the farming system and the actors outside it. In fact, the system is geographically isolated and consumers that do not have

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contacts with the region have often a wrong perception of what it means to be a cattle farmer in the Bourbonnais. This leads to questioning the overall farming activity accusing it to be pollutant and disrespectful of animal welfare. On the other hand, during the FoPIA-SURE-Farm workshop, the participants did not assign very high importance to the attractiveness of the area, suggesting a lack of interest in building connections with actors outside the regions. However, they suggested that a possible strategy for the future should be to build a positive image of the Bourbonnais, promoting a connection with actors outside the farming system.

Functional and response diversity

At the farm level, diversification of crops and productions, as well as buyers, was one of the most mentioned strategies in the farming system in order to respond to price fluctuations. Some farmers, but not all, were considered also willing to experiment new practices. For responding to droughts the main strategy was about storing feeds, even if some other strategies were mentioned like adapting cows' diet to available feeds. However, not many diverse response strategies were mentioned

At the farming system level, functional diversity is observed in the way of preventing debts for farmers. There is a multiplicity of actors that can provide farmers with sustainment in case of investment or in case of negative events. These actors are banks, insurance companies and cooperatives that in case of need can provide money. Also, different forms of securing incomes were mentioned, such as contractualization or insurance. Concerning the diversity of farm types, the FoPIA-SURE-Farm workshop mentioned diversity in farm types and sizes.

Spatial and temporal heterogeneity

At the farm level, some farmers are promoting diversification of crop, productions and buyers. Other than that, the landscape is manly constituted by grassland and does not show big heterogeneity.

Exposed to disturbance

In the challenges the main disturbances are droughts (increasing in frequency in the last years), price volatility, cattle diseases, and changes in the CAP policy on study region, and continuous questioning of the practices by consumers from outside the study region. So, the system is quite exposed to disturbance. Indeed, some participants to the FoPIA-SURE-Farm workshop and some interviewees recognized that being exposed to droughts, diseases, and price changes helps the system to transform and find solutions.

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Coupled with local and natural capital

We believe this is one of the most important resilience attribute in the farming system. Indeed, the system is almost completely based on grasslands. Farmers and local citizens value this important aspect of the system and are completely aware that the two systems (farming system and natural landscape) are sustaining one another. Local people and farmers are proud of the high quality of their products and by the fact that this kind of farming ensures animal welfare. In addition, policy protects this landscape which has undoubted aesthetic qualities and value grassland.

Being coupled with the natural capital, however, exposes the system to risks related to droughts. In fact, the yield of grassland is strongly related to rainfall and this hampers the development of new emerging practices, e.g., the grass fattening. The progressive drift away from cattle rearing to crop cultivation can be seen as an erosion of the dependence of the system on natural capital.

Reflective and shared learning

The learning capacity interviews revealed that farmers are willing to acquire new skills and information through other farmers and this is particularly possible by attending farmer associations and cooperatives, where they can share ideas and experiences. Other information are found on the internet. However, the attitude to learning varies a lot among farmers, open-mindedness and willingness to test new innovation is of primary importance.

Globally autonomous and locally interdependent

The Risk Management workshop discussed this resilience attribute under the umbrella strategy of achieving food self-sufficiency. Some limitations towards the achievement of this resilience capacity are indeed lacking in the farming system. Participants to the focus group pointed out a lack of coordination between the actors of the value chain, a lack of support by policy (for example, policy could promote the consumption of local food in school canteens), and a lack of willingness to pay by consumers for local products. So, the system is still quite far from being autonomous and locally interdependent, even if there are some contributing factors, such as the presence of cooperatives that facilitate exchanges between farmers.

Builds on human capital

The system is now facing a demographic challenges with an overall ageing of population. If the presence of long-term farmers is precious for sharing of the experience, the younger generations are not always formed for becoming the next generation of farmers. Some farmers' kids decide

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to work in other sectors, and for those who want to become farmers from outside the family it is difficult to find the economic means to start the activity.

Reasonably profitable

One of the challenges pointed out almost all the activities is the low profitability of cattle farming in the Bourbonnais, mainly because of the higher and higher price of inputs and lower and lower meat price.

Concluding remarks on resilience attributes

In order to conclude on the overall resilience attributes, we summarize with a more synthetic view on the five attributes by the Resilience Alliance (2010), indicating, for each attribute, the enhancing and the constraining factors in the Bourbonnais farming system (Table 4.4).

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Table 4.4. Enhancing and constraining factors at farming system and farm level for each of the five resilience attributes proposed by the Resilience Alliance (2010).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	More and more diversification in terms of crop cultivation. Diversity of ways to contrast indebtedness (e.g., insurance, banks, cooperative, contractualization). Adding value to the product, not only quantity but also quality and other forms of selling (e.g., direct selling on farm).	Overall ageing of the farm population, poor intergenerational renewal.	Diversity of cultivations, productions, buyers.	Policy is not flexible and does not account for specific cases.
Openness	High exposure to disturbances (droughts, price fluctuation, consumer expectations).	Low importance assigned to the attractiveness of the area.	Questioning of practices by consumers sometimes taken as a driver for change. Open-mindedness and willingness to experiment new practices.	Strong willingness to transmit the farm only to a family member. Lack of time.
Tightness of feedbacks	Presence of cooperatives and farm organization that promote exchanges between farmers and other actors.	Some actors in the value chain are not close to farmers problems (e.g., banks, policy makers and the social security).	Engaged in farmers associations.	Difficulty to adapt to a constantly changing CAP. Lack of time.
System reserves	Presence of insurance and policy promotes insurance Coupled with the natural capital. Possibility to add value on the production through quality and animal welfare.	Relatively low profitability. Dependency on climate.	Investment in technologies for storing feed.	Difficulty to find a successor or an employee.
Modularity	Local consumer value the landscape. Complementary between livestock and vegetal resource in the context of a landscape of high aesthetical quality.	Lack of coordination among the value chain actors.		

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4.8 ADAPTIVE CYCLE

The elaboration of the information issued by the SURE-Farm activities in the Bourbonnais made it possible to make considerations about the relation of the current farming system to the adaptive cycle (Figure 4.9). On average, the system is on the conservation phase, however, we believe that better insights can be provided by the analysis of single processes, i.e., risk management, governance, farm demographics, agricultural production.

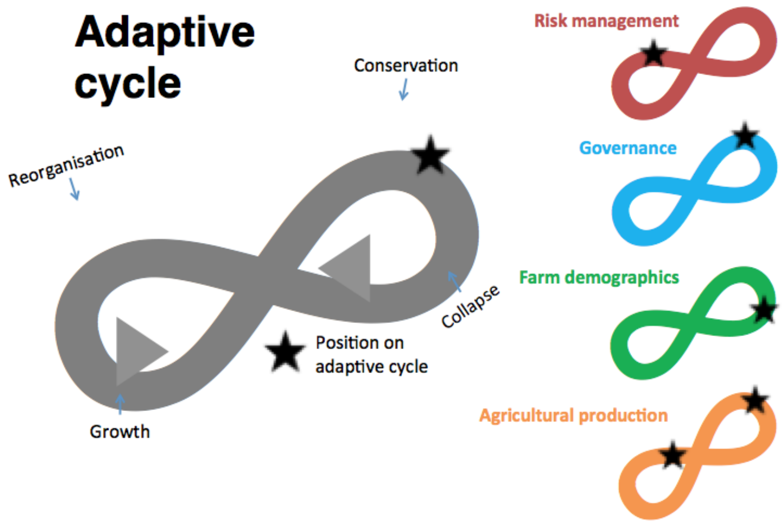

Figure 4.9. Positioning (indicated with a star) of the current farming system of the Bourbonnais on the adaptive cycle. The main, bigger, adaptive cycle depicted on the left part of the figure represents the overall system, the smaller cycles represented on the right represent the single processes.

Concerning risk management, we argue that, although a part of the system stays in the conservation phase (farmers not willing to change their practices, lack of coordination between actors of the value chain), another part of the system was exposed to challenges and is going through a reorganization. Main challenges were an increasing frequency of droughts, recent and imminent opening of the foreign market, and increasing volatility in prices. Some strategies are being implemented to mitigate the negative consequences of droughts and to promote some strategies to prevent over-indebtedness. The role of cooperatives is being fundamental to promote exchanges of experiences and mutual help between farmers. Also at the level of single farmers, there are more and more implementations of strategies of feed storage and production diversification. The participants to the FoPIA-SURE-Farm workshop showed awareness of the changes occurring in the farming system and the more and more demanding society about meat consumption. So there are some attempts for reorganization, which should be consolidated to enter the phase of growth.

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Concerning governance, we think it is deeply in the conservation phase. Insights from the ResAT analysis reveal that policies are focused on the conservation of the status quo. Analysis of the demographic and learning capacity interviews pointed out the lack of flexibility of public policy and the absence of considerations for special cases. In addition, the excessively complicated administration procedure is negatively affecting the quality of life of the farmers and the overall performance of the system. The Risk Management focus group highlighted that policymakers can improve the system in many ways, but they simply avoid committing on this.

Concerning demography, we argue that the system is on the phase of the collapse. The AgriPoliS workshop highlighted the aging of the population and the "baby boom effect": the policy of the 90's made it possible the start of the activities of many farmers; however, the policy did not continue in this direction and in these days it is difficult for a new farmer to take over the activity, as family members are attracted by other jobs and non-family members willing to start the activity are hampered by economic difficulties. Also the weight of the tradition plays a role of conflict between the two generations. The demographic process is on the phase of collapse and because of this new, synchronistic, generational change, and for sure the system will have to reorganize in the next years.

Concerning agricultural production, there are indeed two groups of farmers. Those that are more linked to tradition and those that are more open-minded and look for new ways to face the new challenges. Among the innovators, we find farmers that promote direct selling and find ways to add value on their production. Some farmers promote the diversification of crop production cultivating more cereals beside cattle farming, even this means for the farming system to lose some of the identity of grassland-based extensive cattle system. We think that it is appropriate to tick two points on the adaptive cycle corresponding to the two different groups of farmers.

4.9 FUTURE STRATEGIES

Apart from strategies that have been already implemented and are being implemented in the Bourbonnais, the FoPIA-SURE-Farm workshop and Risk Management workshop revealed also other strategies that at the moment are not at all or not very implemented, but, according to the participants, should be implemented more. Strategies already discussed are:

- Professionalize the workforce (from the FoPIA-SURE-Farm workshop)
- Facilitate the installation of new farmers (from the FoPIA-SURE-Farm workshop)
- Building a positive image of the Bourbonnais (from the FoPIA-SURE-Farm workshop)

Other strategies that were mentioned in the Risk Management focus group that could be implemented in the future are the following. Definitely the first two strategies are important in the context of the position of the farming system on the adaptive cycle in relation to farm demographics. Farm demographics process is in the phase of collapse and therefore new strategies are needed for facilitating the organization phase, particularly in relation to facilitating the installation of new farmers. Building a positive image of the Bourbonnais would strengthen the organization phase for the adaptive cycle in the risk management process (for the specific risks related to social expectations) and would smoothen the transition to the growth phase.

Improve the coordination among actors of the value chain

According to the workshop participants, this strategy is fundamental for achieving self-sufficiency in the Bourbonnais and to strengthen the position of the farming system on the reorganization phase in the risk management process. At the moment this strategy is only partially implemented and would require a better coordination between the actors of the farming system, mainly feed and equipment suppliers, buyers, and retailers. Cooperatives and farm advisors have a key role as intermediary or consultants to get to a better and fairer definition of prices that cover the higher production costs. Farmers should contribute by welcoming new practices and experiment. Cooperatives and farm advisors contribute also by knowing the problems of the farmers and proposing solutions. Key roles, at the moment not implemented, should be played by policymakers and by consumers. In particular, consumers have a big impact in all the value chain and should commit in taking more responsibility and pay higher price for high-quality French meat.

Improve access of farmers to public markets

This strategy would help farmers in achieving better profitability and in promoting the food self-sufficiency of the region. Policymakers can help farmers by assuring a part of the public market, for example in promoting the consumption of local food in school canteens. Concerning the adaptive cycle related to governance, this strategy would surely move the system from the conservation phase to the reorganization phase.

Promoting communication between farmers and other actors

Even if this strategy is already performed, it should be strengthened to facilitate the transition in the reorganization phase of the various processes of the farming system. Contacts between farmers and other actors of the farming systems are vital to promote innovations and in finding new solutions. At moment cooperatives are considered to do a good job in that and farmers associations promote exchanges of experiences between farmers and ensure the availability of workforce in case of accidents (help among farmers)

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Commit in a better tax policy

The participants to the Risk Management focus group highlighted that this is a strategy into which policymakers should only commit. A good tax policy might allow to redistribute public money in order to solve some key problems of farming activities, first of all, the high level of indebtedness into which farmers run into when starting the activity. Also this strategy would move the farming system from the conservation phase to the reorganization phase concerning the governance adaptive cycle.

Changing practices to meet social expectations

While this strategy is being implemented and social expectations have been drivers of farmers decisions for a long time (see Demographic and Learning Capacity interviews), it is most likely that this strategy will be at the core of the decisions at the farm and at the farming system level for a long time. In particular, it consists, for example, in reducing the use of pesticides, optimized fertilization, reduced or stopped ploughing. As for building a positive image of the Bourbonnais, this strategy is a form of reorganization in the adaptive cycle.

Contractualization

Even if already applied, this strategy was highlighted to be very effective and promising for the future. Contractualization consists in assuring to farmers that a certain amount of their production will be sold at a certain price despite market volatility. This strategy smoothens the transition through the reorganization phase.

4.10 CONCLUSIONS

The activities carried out in the Bourbonnais in the first half of the SURE-Farm project revealed a system very well coupled with the natural capital, producing high-quality beef, with high standards of animal welfare. However, the system is exposed to challenges, most importantly related to an increased frequency of droughts, a weak role of farmers in the value chain, demographic challenges (due to low profitability, low attractiveness of the job, and high level of indebtedness for starting the activity), public distrust about beef production, and a policy with frequent changes and not flexible for single specific cases. Farmers are mostly responding with strategies related to robustness, by storing feed for mitigating drought consequence, by subscribing to insurance schemes and by diversifying their production and buyers (this last strategy is however conceived deleterious for the identity of the Bourbonnais which is characterized by a grassland-dominated landscape). The farming system level is mostly responding to challenges with strategies related to robustness and adaptability. Robustness is mainly enhanced by insurance schemes and financing schemes by banks and cooperatives; adaptability is mainly enhanced by the presence of

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cooperatives that facilitate exchanges, mutual help between farmers and other actors. Concerning possible future strategies, different participants and actors highlighted the need of a better adaptability and transformability for the farming system. Open-mindedness and increased learning capacities by the farmers were mentioned as fundamental characteristics to cultivate for farmers, however, what is desirable is an overall adaptation of the whole farming system that should be supportive to farmers in different ways, for example by improving the coordination of the whole value chain for promoting local food production, building a positive image of the Bourbonnais for decreasing public distrust. The application of these strategies, especially if all at the same time, could even constitute a transformation of the system. Last but not least, policy should engage in formulating a better tax policy and in support farmers in different ways, for example promoting the consumption of locally produced food in school canteens. The system is overall exposed to disturbance by droughts and social questioning of farming practices. These were considered as valuable triggers for the transformability of the farming system as farmers and the various actors are pushed to find always new solutions.

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5 CASE STUDY SPAIN

Bárbara Soriano, Daniele Bertolozzi and Isabel Bardají

5.1 ABSTRACT

The farming system is the extensive sheep farming system in La Hoya de Huesca (Huesca), located in the region of Aragón, North East Spain. The region knows a long history of ovine production. It comprises mainly medium-size, extensive or semi-extensive farms that are diversified in other productions such as almonds, olive trees, cereal crops and, in a few cases, vineyard.

The assessment of the current resilience of the farming system follows the resilience framework proposed by Meuwissen et al. (2019) by responding the following questions: i) *Resilience of what?* The farming system is made up of seven actors with mutual dependence with farmers: crop farmers, veterinarians, cooperatives, farmers' associations, distributors, local public services and research centers; ii) *Resilience for what*? The main essential functions of the farming system are to ensure enough farm income and deliver of high-quality food products. Animal welfare and maintaining natural resources are also important functions of the system. The indicators of the provision of private goods show a downward trend during the last 20 years. No adequate indicators exist to measure the provision of public goods. Farming systems actors claim that the public services provided by the extensive farming system have showed a good performance over the last years, though they could no longer remain if the number of ewes keep diminishing in the farming system.; iii) *Resilience to what?* The farmers and farming system have been mainly facing long-term economic, social and institutional challenges (low profitability, the low attractiveness of the sector and the insufficient aids systems); iv) *What resilience capacities*? The strategies implemented in the sector strongly focus on improving adaptability, moderately focus on robustness and in a lower extent to transformability; and v) *Which resilience attributes*? Reasonable profitability, support rural life, diverse polices, coupled with local and natural and socially self-organized show a performance relatively poor, and do not sufficiently support the processes of farm demographics, agricultural production, risk management and governance. Policy goals and instruments have not been able to properly support the provision of private goods nor to enhance the provision of public goods. This leads to conclude that the general resilience is at a relatively low level in La Hoya de Huesca. This assessment is summarized in the fact sheet below (Figure 5.1).

The resilience assessment allows concluding that the extensive sheep farming system in Aragon is in the decline phase in the adaptive cycle. It is hard to conclude if the system reached its lowest point. It might also be possible that the system will further collapse when new challenges present themselves.

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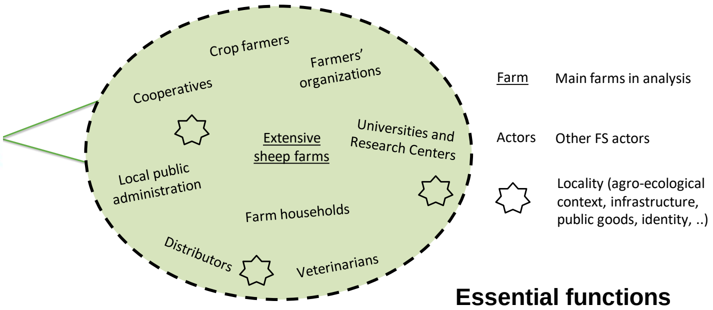
Farming system

Hoya de Huesca (SP)

Extensive sheep farmig



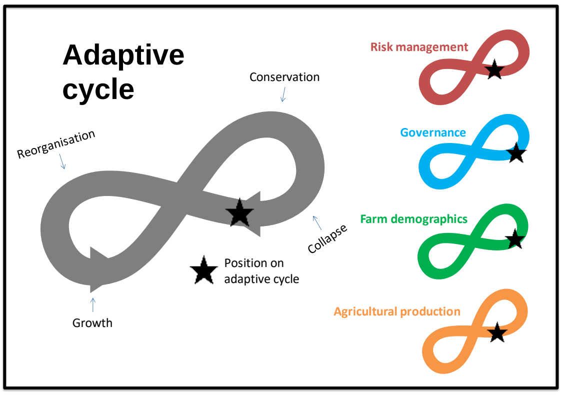
Challenges

Institutional:
- Low and decoupled aids;
- Unequal aids´ distribution;

Environmental:
- Conflicts with wild fauna;
- Climate change and droughts;

Economic:
- Low profitability
- Reduction of meat consumption

Social:
- Depopulation and lack of skilled labour
- Poor quality of life



Essential functions

Private goods:
- Ensuring economic viability: *low performance*
- Delivering food products: low-*medium performance*

Public goods:
- Maintaining natural resources in good condition: *good performance*

Need more attention

! Increasing attractiveness of rural areas and quality of life: *low performance*

Resilience capacities

The robustness capacity is low

There is an evident, although not prominent, capacity to adapt by implementing a number of innovations and novelties in farm management

The capacity to transform is not significant.

Current policy configurations slightly constrain robustness and slightly enhance adaptability. Almost no impact on transformability.

Resilience attributes

Diversity: low	Mixed farms with diverse functions The lack of diversity of policies supporting provision of public goods is limiting the diversity of the system.
Modularity: low	Reduced number of farms and farm types . Limited spatial and temporal heterogeneity
System reserves: low	Depopulation and lack of social capital and skilled labor; Lower access to pastures Policy instruments on buffer resources
Tightness of feedbacks: low to moderate	Good degree of associationism Initiatives as PGI are improving connections with outside the farming system
Openness: moderate	The sector is open to innovations Lack of policy instruments and investors to open the sector

Future strategies

Risk management
- New insurance for new risks (diseases)
- Improved grasslands insurance
- Financing products adapted to farmers needs.
- Training, information and cooperation to deal with risks

Governance
- More equitable aids distribution
- Support the provision of public goods
- Enhance transformability (processing and retail activities)
- More attention to gender issues
- Public awareness about the extensive farming and its contribution to environment conservation

Farm demographics
- Support the training and knowledge sharing
- Facilitate contact between exit-entrant farmers
- Enhance the young and women entrance
- Enhancing the attractiveness of remote areas and farming
- Stimulating succession via easier access to land

Agricultural production
- Animal handling technologies
- Consumer oriented strategies
- Introduce new rainfed/irrigated crops variety
- Feeding extensification (transhumance)
- Feeding Intensification (new and cheaper feed products)

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Figure 5.1. Factsheet synthesizing resilience of the current faming system in Huesca.

5.2 FARMING SYSTEM

The Spanish case study is the extensive sheep farming system in Huesca, located in the region of Aragon, Northeastern Spain. Its territory comprises a mountainous geomorphology to the North, and a mainly flat area in the South. Such geographical characterization implies different farming: more extensive and livestock-addressed to the north, and more intensive and crops-addressed to the south. The province knows a long history of ovine production and the practice of transhumance (Navarro, 1992). The extensive sheep farming system in Huesca comprises mainly medium-size, extensive or semi-extensive farms (300-800 ewes). In many cases, farms are diversified in other productions such as almonds, olive trees, cereal crops and, in a few cases, vineyards (Aragón Government Statistical Database, 2019; Pardos et al., 2008). The number of farms has declined over the last twenty years form 487 farms in 1995 to 199 farms in 2015. It represents a drop of 62% (Castellano Prat, 2016). The number of ewes also has drop from 159.000 in 1995 to 77.900 in 2015, a drop of 51.66%. The area is undergoing an intense process of depopulation (Bosque and Navarro, 2002).

As part of the FoPIA-SURE-Farm workshop preparation, a map of the farming system was developed (Figure 5.2). The farming system embraces of all the actors who mutually influence each other (Meuwissen et al., 2019). In the centre of the system are the farmers and farm households closely connected with the veterinarians, the farmers associations and cooperatives. Local public administration, universities and research institutes, distributors and crop farmers (as land / feed providers) are also closely linked to sheep farmers.

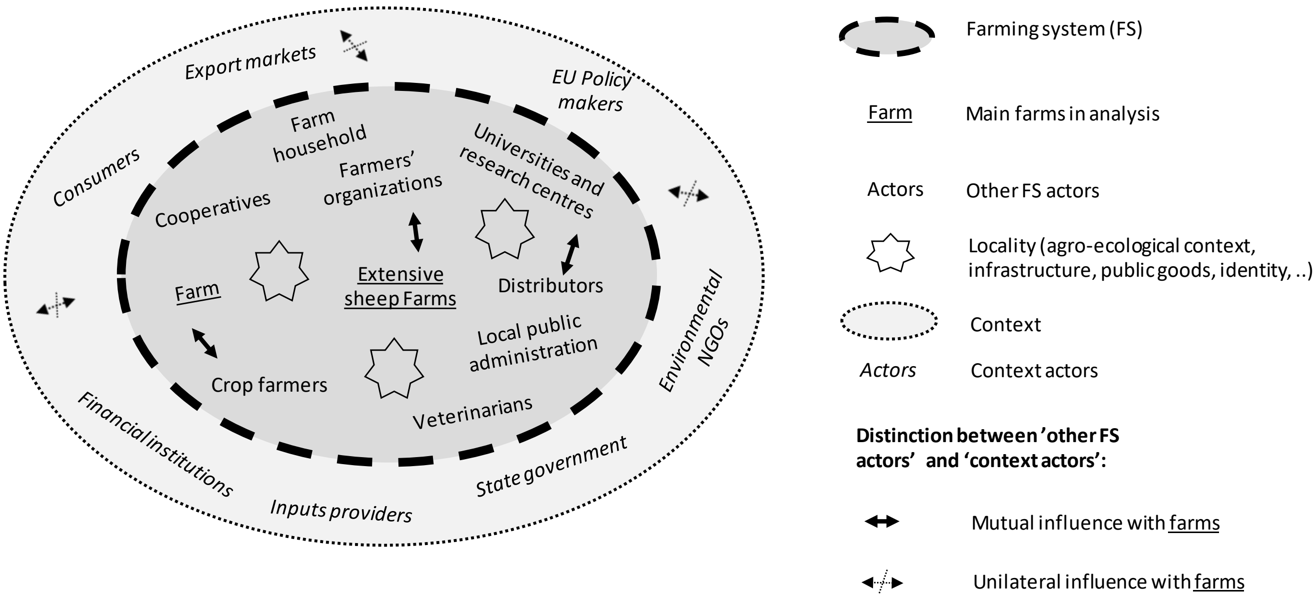

Figure 5.2. Farming system in the extensive sheep farming in Huesca.

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5.3 CHALLENGES

The diverse challenges faced by the farming system are summarized in Table 5.1. The challenges are organized according to their nature (environmental, economic, social and institutional), impact (shocks, long term pressures) and the method used to identify them.

Table 5.1. Summary of challenges across methods.

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Sheep extensive farms	3	2	3	1 (most relevant)
	Shocks	Learning & Demographic interviews	Droughts Wild fauna attacks		Sickness of family members	
	Long-term stresses	Learning & Demographic interviews Policy interviews	Wildlife protection Land abandonment Erosion Climate change	Low profitability Increasing competition for access to land Increasing competition with intensive livestock systems	Reduction of meat consumption Decreasing population Lack of skilled labor Work intensity Low succession Aging population Negative public opinion on livestock farming	Increasing strict rules, bureaucracy and control Changes in objectives and policy instruments Decreasing aids Unequal aids distribution
Households	Shocks	Demographic interviews				Decoupling Land access and eligibility
	Long-term stresses	Demographic interviews	Increasing droughts (climate change)	Steady-low prices Higher labor costs Increasing feeding costs Decreasing farmers' bargaining power	Depopulation Lack of workers Lack of trust in the sector Reduction of meat consumption Low quality of life and work intensity	CAP distortions for historical rights Bureaucracy
Farming system	Shocks	ResAT FoPIA-SURE-Farm	Droughts	High feeding costs		
	Long-term stresses	ResAT FoPIA-SURE-Farm	Conflicts with wild fauna	Low profitability	Reduction in consumption	Changes in policy goals Reduction of aids Increasing bureaucracy Differences in policies between sectors and countries
Farming system (past challenges)	Shocks	FoPIA-SURE-Farm ResAT	Animal diseases			Decoupling Eligible hectares for aids
	Long-term stresses	FoPIA-SURE-Farm ResAT	Land abandonment Erosion Climate change	Low profitability Lamb meat imports	Reduction of consumption Aging population Lack of shepherds and skilled workers Low quality of life depopulation	Lack of rural investments Bureaucracy Not enough support from administration

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5.3.1 Present challenges for farmers and farm households

Economic, institutional, social and environmental long-term pressures have emerged from the learning capacity and demographic interviews analysis. Most of the risks identified are related to the economic dimensions: i) the profitability is generally low due to stable-low prices of lamb meat and increasing feeding and labor costs; ii) there is an increased competition from imports, intensive agricultural sectors and other sectors that increase the competition over land; iii) a decreasing consumption of lamb meat; iv) changing value chain in which local markets (local butchers) are disappearing and farmers have decreasing bargaining power.

Regarding the social challenges, there is a general lack of human resources and an overall phenomenon of leaving the sector and rural areas. Specifically, there is a deep lack of skilled workers and people interested in working in the livestock sector. The sheep sector is very labor intensive and it does not allow a balance between work, family and personal life. The lack of interest in the sector is constraining the transmission of the knowledge to new entrants. Together with the lack of workers, potential successors are not interested in taking over the farm. Indeed, the farmers encourage his sons/daughters not to continue in the extensive farming. New generations study in the cities, and they do not want to come back to the field.

On the institutional side, many challenges have been identified. Two mains issues need to be highlighted: i) The unequal distribution of the aids since the payments decoupling which have forced farmers to exit the sector. It is explained by the fact that the existing coupled payments are not enough to cover the costs. Indeed, the existing aids linked to land, force farmers to look for eligible hectares to be able to receive the aid. Finally, the historical payments become a barrier for new entrants, with no rights to receive these payments.; ii) Administrative controls are tedious and can represent a barrier and imply costs and time for farmers.

Finally, farmers are facing environmental risks such as wolf attacks that are likely to increase in the future; animal diseases which however are currently not a pressing issue and the more frequent droughts that imply higher feeding and pasture costs. Due to labor costs, lack of people interested in long working hours, and the increasing land prices, in many cases herd management tends to become less extensive (the pastoralism limits to a low number of hectares). As a result, the herd grazes fewer hectares which lead to forest abandonment and more likely forest fires.

In the farm survey, farmers were asked to score from 1 to 7 to what extent different events will be challenging for their farms. The extensive sheep farmers considered that the institutional challenges have the greatest impact on their farms (6.26 on average) mainly explained by the reduction in the CAP direct payments. These challenges are followed by price challenges - Persistently low market prices- (6.12 on average), societal challenges - Low societal acceptance of

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agriculture - (5.7 on average) and value chain -Low bargaining power towards processors and retailers- and societal challenges - Low societal acceptance of agriculture- (5.3 on average) and production challenges - Persistent extreme weather events- (5.3 on average). Financial challenges, related to limited access to loans and late payments from buyers, are those with lower impact on the farms (4.2 on average).

5.3.2 Present and past challenges for the farming system

The FoPIA-SURE-Farm workshop discussed challenges that the farming systems faced in the past. The most relevant past challenges cover different dimensions, from social to institutional and economic. The issue of depopulation has been deeply faced; its effect is still affecting the system. The economic and institutional challenges are mostly connected to the CAP reform, which decoupled the aids from 2003 onwards. Other economic challenges influenced the sector as well, such as the increase of feeding costs since 2007-2008. Changes in the sanitary legislation about slaughters implemented in 2004 represented further institutional challenges, which are impacting on the farming system.

5.4 OPPORTUNITIES

5.4.1 Present opportunities for the farming system

Young farmers and cooperatives and farmers' organizations lead the initiatives to pursue the opportunities of the extensive farming system. Young farmers found that there is an interesting room to improve: 1) moving the feeding system of the herd from semi-extensive to extensive farming. This opportunity allows famers to significantly reduce the feeding costs; 2) investing in new technology to reduce the shepherd time demand (electric fence, video-camera, etc) and 3) strengthen the international positions by looking for new international markets where lamb meat is still valuable.

This last initiative is also pursued by the cooperatives in the sector. Cooperatives understand that there are many opportunities in the market by offering new products (meat quality, meat cuts, meat cooking, etc.) to national/international consumers. Interesting opportunities are put in place to increase public awareness about the sustainability of the extensive farming that is coupled with the local natural resources, contributes to their conservation and is source of rural development. Cooperatives identify opportunities to increase the farms efficiency by investing in increasing herd prolificacy.

Now it is time for the policy to value the contribution of the extensive faming to environmental conservation. Farmers organizations are aware of this opportunity and propose to raise public awareness about the extensive sector.

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5.4.2 Past opportunities for the farming system

When analyzing historical dynamics and past challenges, the stakeholders identified past opportunities for those farmers who remained in the sector. Many farmers took the opportunity to increase the size of their farms by buying at a competitive price the herds of the exiting farmers. As herd size increased new workers were needed. Farmers found the opportunity to hire migrant workers. It seems that these opportunities do not exist anymore. Migrant workers move to the city as soon as they get a new job. Indeed, they are un-skilled workers who do not meet the farmers' needs.

In order to increase the farm profitability many farmers have diversified their production (new rainfed crops) and joined the prolificacy programs led by the cooperatives. Transformation by performing new activities such as rural tourism accommodations has been followed by a minority of farmers.

5.5 FUNCTIONS

5.5.1 Farmers and farm households

The farm survey revealed that to 'ensure a sufficient farm income' is the most relevant function of the farming system, followed by 'deliver high-quality food products'. Other functions appear relevant, such as 'ensure animal welfare', 'maintain natural resources' and 'provide employment and good working conditions (Figure 5.3).

Figure 5.3. Essential functions (averages) according to the farm survey. Note: FarmIncome – ensure a sufficient farm income; FoodSupply – deliver high quality food products; NatResources – maintain natural resources (e.g. water, air, soil) in good condition; AnimalWelfare – ensure animal welfare; WorkConditions – provide employment and good working conditions for employees; BiodiversityProtect – protect biodiversity; AttractiveCountryside – ensure the attractiveness of rural areas in terms of agro-tourism and residence; BioEnergySupply – deliver bio-based resources (e.g. hemp, wood) to produce biomass and biofuels

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One of the findings from the interviews is the great attachment of the farmers with the animals. They are worried about the quality of life of the herd and have a strong commitment of taking care of them. Indeed, they are aware about the contribution of the extensive farming to maintain natural resources by avoiding forest fires and keep the rural areas alive.

5.5.2 Farming system

When interviewing farmers and other stakeholders (cooperatives, associations and policy makers) the contribution of the extensive farming to maintain natural resources in good conditions and ensure the attractiveness of rural areas usually predominates. Sheep farming mainly contributes to keep the biodiversity of the region, the soil quality and prevent forest fires by keeping the area clean from weeds and scrubs. Extensive farming keeps farmers and families living in rural areas. It is thanks to them the rural areas remain attractive.

During the FoPIA-SURE-Farm workshop, 'economic viability' was also identified as the most important essential function of the sheep extensive farming system. As explain above, in this occasion also the contribution of the sector to maintain natural resources appears as one of the most important essential function of the sector together with the provision of food.

Figure 5.4 shows the most important essential functions indicators (reflected by the size of the bubbles) and their performance according to their positions on the axis "Y". The most important existing indicators are those referred to the farmers' economic viability and food production, i.e. gross margin, price of lamb, meat production and sheep census. The performance of these indicators has been scored as "low" (lower than 2, in a scale 1-5).

The Figure 5.4 shows a general low relevance of the indicators measuring the essential function of the farming system. One of the main arguments debated during the FoPIA-SURE-Farm workshop is that there are no good indicators to measure the provision of public goods by the sector as one of its major functions. New measurable indicators are claimed by the farming system actors to proper measure the essential functions of the sheep extensive farming. Some examples of the indicators that could be relevant are indicators to measure the lower likelihood of forest fires, the higher soil quality and the greater biodiversity when the land is grazed.

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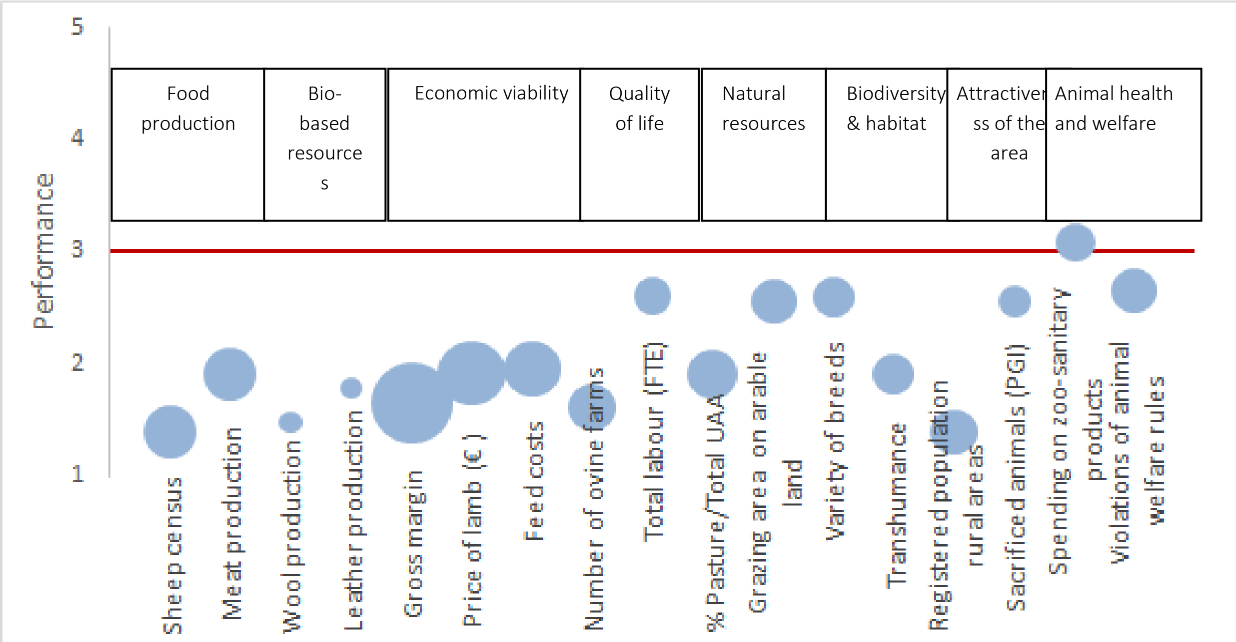

Figure 5.4. Bubble graph presenting averaged scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other. At the top, the related functions are indicated. Assessed by stakeholders in the FoPIA-SURE-Farm workshop.

The ecosystem services (ES) assessment shows that private goods provision (Figure 5.5) score very low, under 0.25. Energy crop production is the highest scored, nearly to 0.25. This figure needs to be adjusted as energy crops are not so important in the region. Next, food crop production is the second scored. Fodder crop production, grazing livestock density and timber removal appear insignificant.

About the provision of public goods (Figure 5.6), water retention, phosphorous concentration, and capacity to avoid soil erosion are the best scored, reaching about 0.5. Next, only habitat quality for common birds and recreation overcome the score of 0.25. Other services are low scored.

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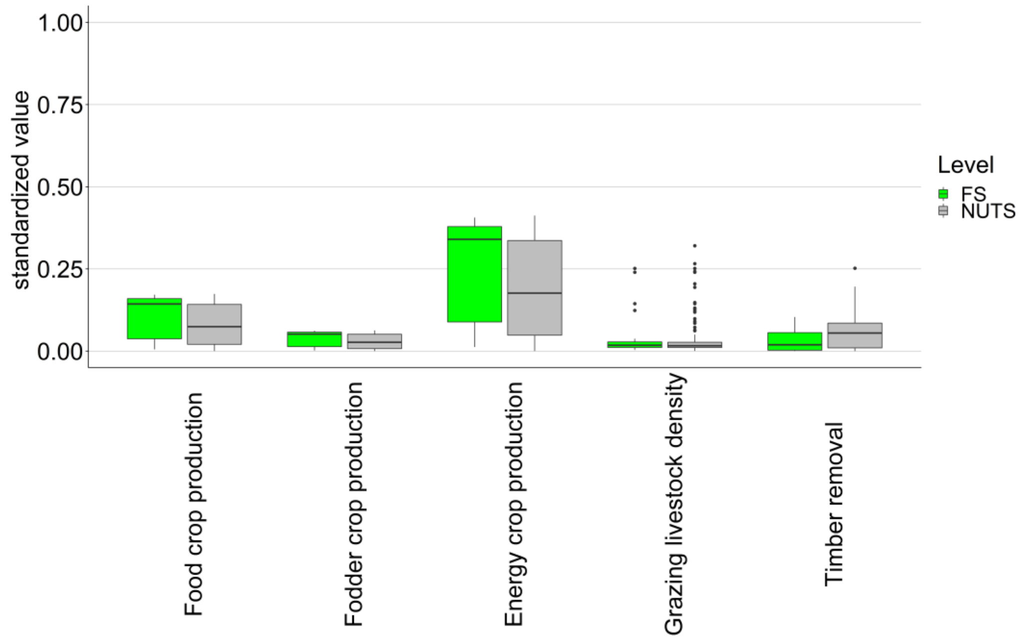

Figure 5.5. Current performance of ecosystem services related to private goods according to the ES assessment.

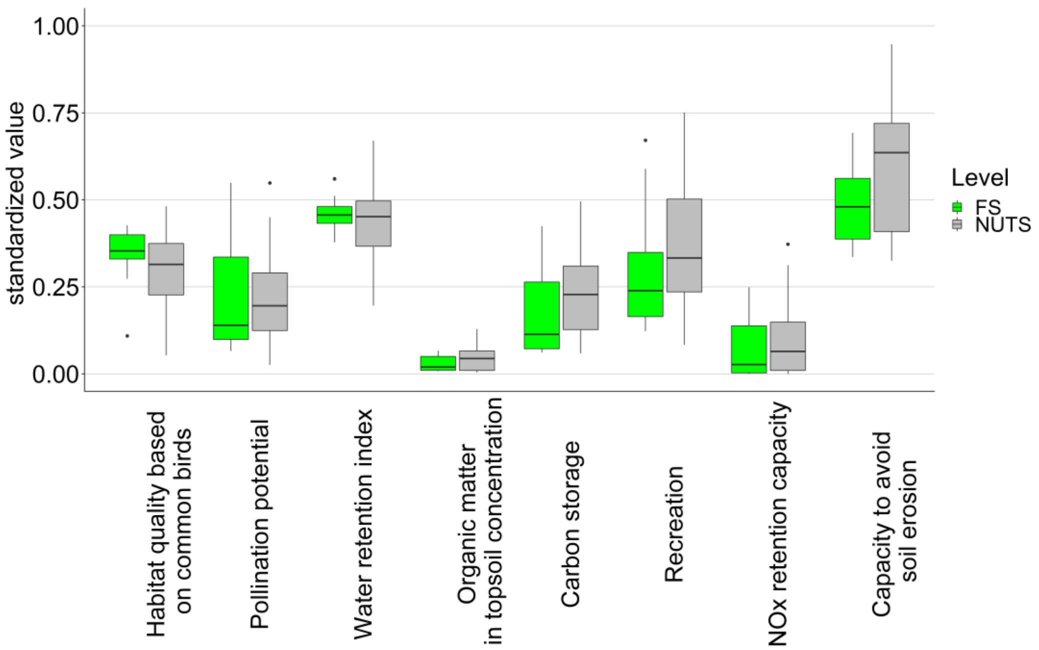

Figure 5.6. Current performance of ecosystem services related to public goods according to the ES assessment.

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5.6 RESILIENCE CAPACITIES

5.6.1 Farmers and farm households

According to how the farmers consider their own resilience capacities, adaptability scored the highest on average, with 3.74 followed by transformability (3.20) and robustness (2.89) (Figure 5.7). The differences are not statistically significant. Farmers have been experiencing the downwards trends in the number of farms and farmers in the sector over the last 20 years. This situation may explain why farmers score robustness the lowest.

Those farmers who are still in the sector have felt a strong pressure of the low profitability of the sector and the lowering CAP aids. The remining farmers have demonstrated their capacity to adapt to face the major challenges of the sector. Part of them also has initiated new activities in the farm to remain in the sector by investing in irrigation, other cattle (bovine, pigs) or tourism activities.

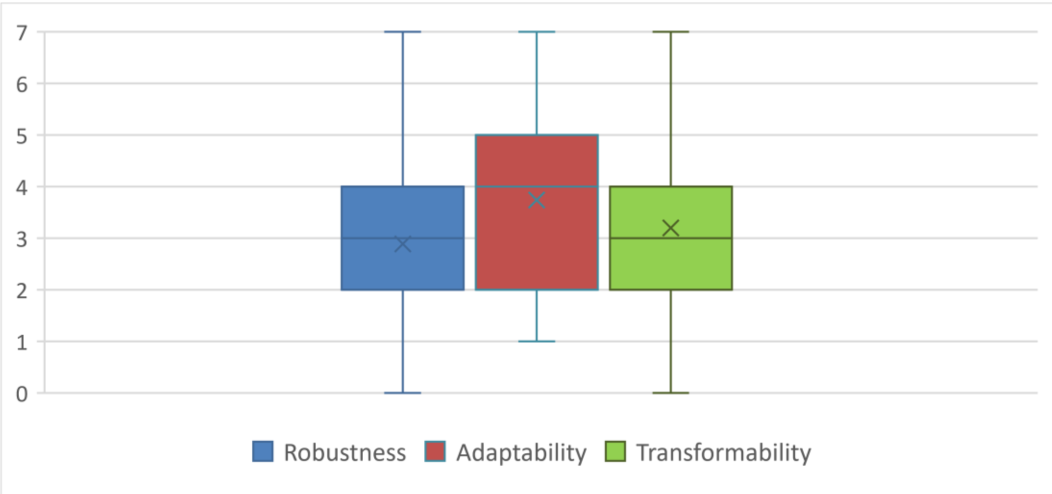

Figure 5.7. Scores for the three resilience capacities based on the farm survey.

In the learning interviews, farmers explained that they have needed to be robust to deal with hard times by dedicating more time, using the savings, or asking family or friends for extra-support. Adaptability capacity emerges through the mentioned strategies such as adapting animal handling (feeding, prolificacy, and management), investing in IT (electric fencing video /remote surveillance), belonging to cooperatives, adapting herd sizes, and improving meat quality. The cooperatives and research centres/Universities are the main sources of learning for implementing these strategies.

5.6.2 Farming system

Strategies' contribution to resilience capacities has been scored according to the stakeholders in FoPIA-SURE-Farm (Figure 5.8). In general terms, the strategies contribute to the three resilience

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capacities but to different extent. Most of the strategies contribute to the greatest extent to adaptability, such as modernization, innovation, specialization of the farms, cooperation, product differentiation and improve genetics. Some strategies have mainly contributed to robustness, such as contract foreign labor, the interprofessional cooperatives, CAP aids and improve management and nutrition.

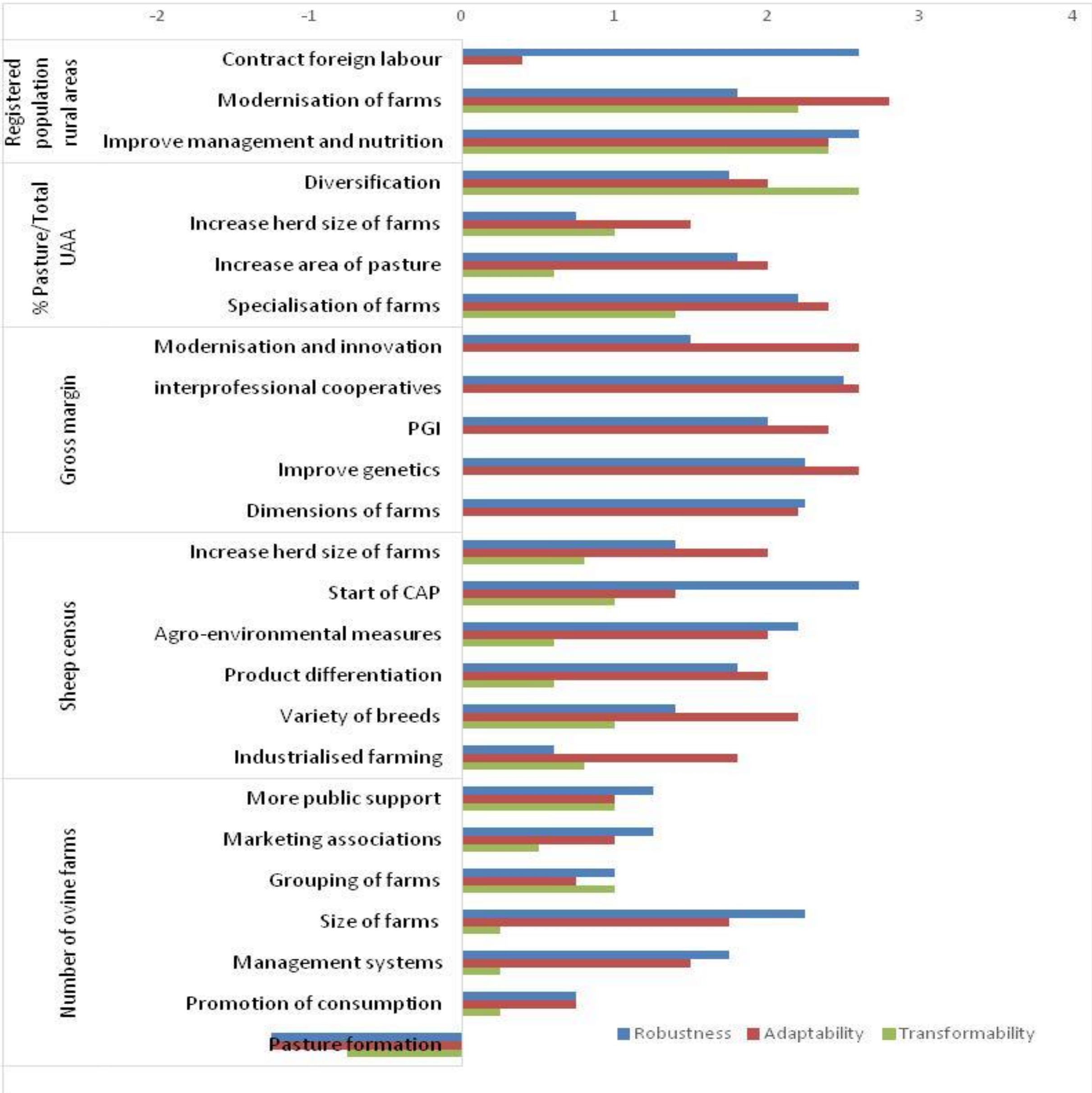

Figure 5.8. Strategies applied to cope with challenges affecting the indicators of the essential functions and their perceived contribution to the three resilience capacities according to stakeholders participating in the FoPIA-SURE-Farm workshop

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Strategies contribute to the lowest extent to transformability. Diversification, improve management and nutrition, and modernization of farms are the only strategies significantly enhancing transformability.

As showed in Figure 5.9, most of the policies (above all from 1º CAP pillar) aim at supporting the current state of the system and at conserving it by means of a buffer. However, in practice those instruments do not seem capable to support robustness, and potentially they slightly constrain it.

Policy' goals seem to be favorable to adaptability, and to enhance this capacity. This is particularly referred to the 2º pillar of CAP. Nonetheless, instruments could enhance adaptability just partially.

Policies do not seem to support the transformability of the system; there is no evident intent to reach this goal. Consequently, policy instruments are not suitable for transformations, even though some measures of the second pillar CAP may be used in this sense.

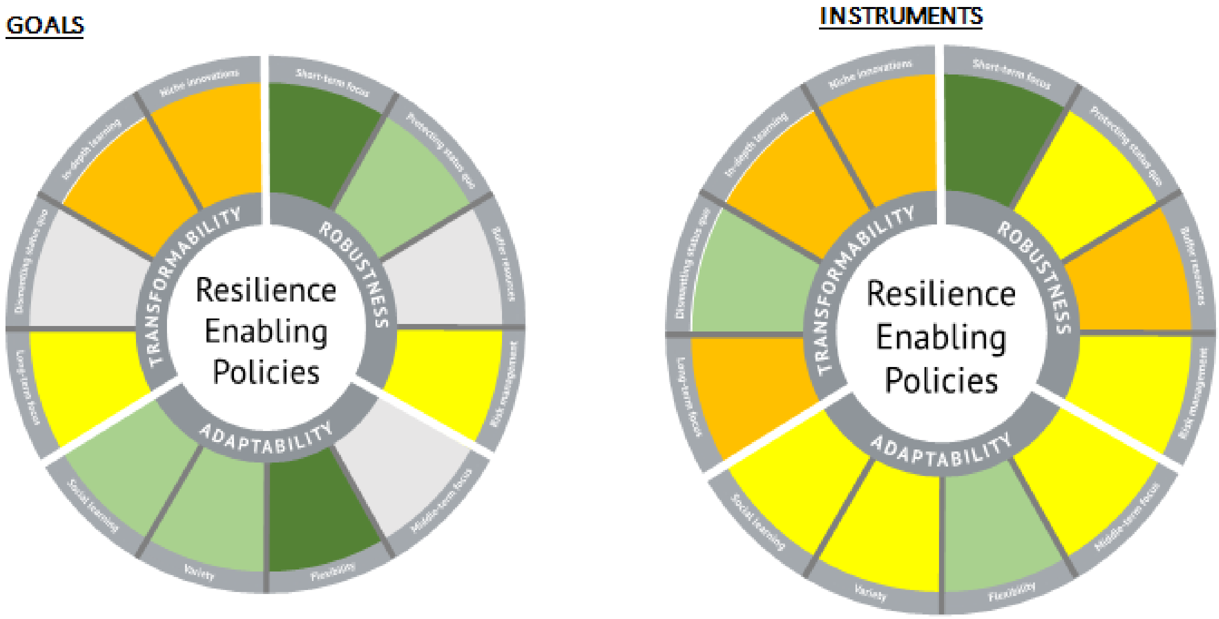

Figure 5.9. The ResAT wheel applied for the sheep farming system in Huesca. The attributes are the key characteristics for resilience-enhancing policies. The given colors indicate to what extent the key characteristic is enhancing or constraining the resilience capacity (Red = Not enhancing or very constraining; Orange = Slightly enhancing or constraining; Yellow = Fairly enabling or fairly constraining; Light green = Enhancing or slightly constraining; Dark Green = Very enhancing or not constraining).

5.6.3 Concluding remarks on resilience capacities

Overall, there is accordance between results at farm and farming system level upon the prevalence of adaptability. Robustness emerges evidently at both farm and farming system levels, but is limited by policy actions. Transformability seems to be perceived differently at different

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levels. Farmers perceived that they have greater capacity to transform than to be robust. Such transformability has been pursued mainly through modernization, innovation, specialization, and cooperation, between the others. The source of robustness perceived by farmers is the own farmers' personal and economic efforts and farmers' cooperation. At farming system level, stakeholders consider that farming system has a greater capacity to be robust than to transform. The difference may be due to differences in methodology.

5.7 RESILIENCE ATTRIBUTES

5.7.1 Farmers and farm households

Considering the resilience attributes in the context of the five generic principles of resilience as proposed by the Resilience Alliance (2010), the enabling attributes in the farming systems are the diversity, the modularity and the tightness of feedback. The constraining attributes are the reserves and the openness.

The farming system specialization is the mixed farms in which farmers combine livestock and crop production. Although the farmers activity is mainly based on sheep livestock, many farms count on other productions such as other extensive (cow) and intensive (pig) livestock, crops, almonds, olive trees, and vines. Farmers provide diverse functions and responses by performing these activities. Regarding the tightness of feedbacks, learning and demographic interviews showed us the importance of the existing networks to learn, keep trained and join the opportunities of innovation. However, the networks are limited to the family networks and the cooperatives and farmers' associations.

The lack of reserves is identified as a constraining attribute. The lack of reserves can be assessed from different dimensions: i) low profitability of the sector, ii) lack of skilled people interested in working in the sector. Salaries and living conditions in rural areas are not enough to attract skilled workers; iii) lack of population living and keeping alive the rural areas; iv) lack of knowledge due to there is no adequate knowledge transfer structures to avoid knowledge loss; v) lack of savings, as the system has remained in a very low profitability during the last 20 years, the farmers have not been able to build monetary reserves enough to invest and deal with challenges; and vi) low access to land.

Low openness also is seen as a constraining attribute. There are hardly mentioned relationships between the extensive sheep farmers and other sectors surrounding that contribute to build new opportunities for the farmers.

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5.7.2 Farming system

In the FoPIA-SURE-Farm workshop, stakeholders were asked to score the relevance of the attributes to explain the farming system resilience. Stakeholders considered that most attributes are relevant (Figure 5.10). The scores are between 3 (moderate extent) and 4 (big extent). The highest scoring attributes on relevancy were the reasonable profitability (mean = 4.6), diversity of policies (3.9), supporting rural life (3.8) and coupling with local and natural capital (3.7). The lowest scoring attributes for relevancy were exposed to disturbances (3.0), appropriately connected with actors outside the farming system (3.1) and response diversity (3.2).

Actors in the farming system explained the relevance of the resilience attributes: i) Reasonable profitability, that enables robustness (keep savings and low debts for hard times) and facilitates investment towards adaptability (new technologies to reduces costs and increase productivity; ii) Support rural life, to keep families and skilled labor force in rural areas; iii) Diverse polices that support farmers to deal with the low profitability and enhance the contribution of the sector to the environment and rural development; iv) Coupled with local and natural, to ensuring the availability in quantity and quality of pastures and biodiversity; and v) Socially self-organized-, an important attribute for intensive and skilled labor sectors. Shepherding requires farmers to be a lot of time with the animals and to have the knowledge enough to do it in a proper way. An adequate knowledge transfer is key for the sector.

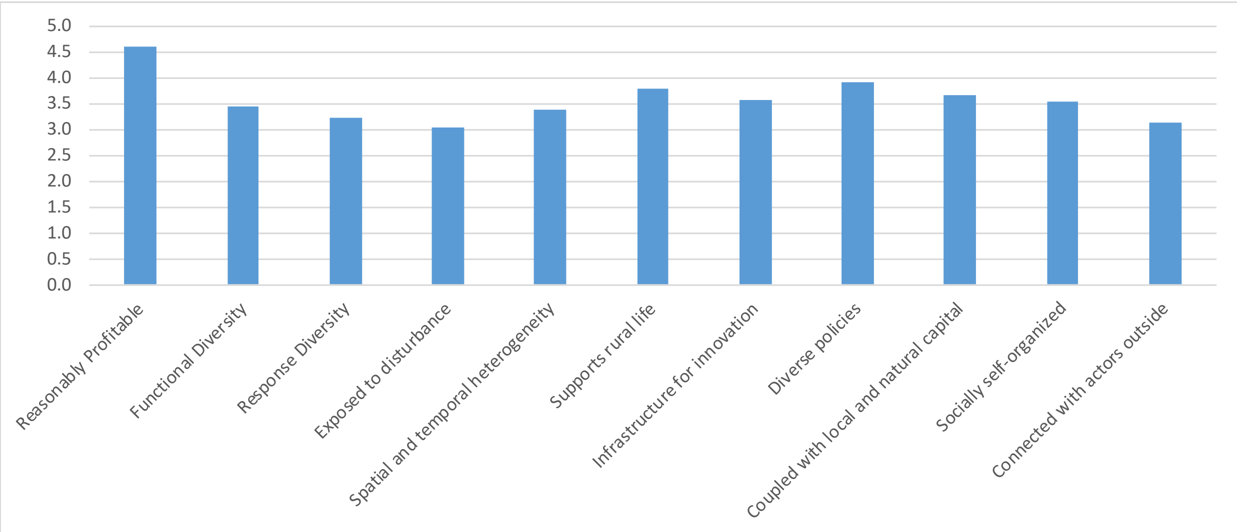

Figure 5.10. Relevance of resilience attributes in the farming system. Relevancy is scored as 1 = not at all, 2 = small extent, 3 = moderate extent, 4 = big extent, 5 = very big extent (n=24), n=24

Regarding the *diversity*, the farming system is system is diverse when considering the farm types in the region. Many farms are mixed, and do not only rely on ovine production. Many of those

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mixed farms produce different livestock or crops next to their main practices. Diverse activities provide diverse functions, from food production to contribute to environment conservation.

The *openness* of the farming system is represented by the exposedness to perturbations and the infrastructure for innovation. At first, the exposedness to perturbation was scored as the least relevant attribute for the system by the participants. Interestingly, Cabell and Oelofse (2012) state that this attribute is important to make the system more resilient and more adaptable. However, they argue that a system only benefits when the perturbations are small and controllable. The system has been much protected for a long time until the CAP decoupled payments in 2003. From that year onwards, it can be noted that several indictors went through a collapse (dynamics of indicators exercise). It can thus be stated that the exposedness to perturbations was too abrupt and too strong in that case. It seems that the sector is now more open to fluctuations in prices due to the increased globalization. The overall openness of the system seems to be improving towards a more resilient state. Infrastructure for innovation within the area is not strongly present. The system lacks behind on modernization and the application of innovative improvements. Furthermore, the connection with actors outside the farming system is still very low. However, currently initiatives such as the Protected Geographical Indication (PGI) might improve those connections.

Regarding the *reserves*, the specific resilience attributes “reasonably profitable” and “coupled with local and natural capital (production & legislation)” and “supports rural life” are contributing to the general resilience principle system reserves. Clearly, relying on the system reserves has been a very important strategy for this system to deal with shocks and pressures. Throughout the course of the years it was visible however that the system reserves became depleted. For example, a lack of social capital arose when the region population decreased too much and there was a lack of skilled labor. Furthermore, access to pasture lands became lower. Also, farmers lack the capital to invest in more modern technologies. The coupling with local and natural capital is very important for the system. This coupling has traditionally been very strong, as it is an extensive system. There used to be little inputs from outside the farming system. However, more recently, due to modernization and intensification, farmers started to import more resources into the system. This thus leads to a decoupling of the system with the local natural capital.

The performance of *tightness of feedbacks* (socially self-organised and appropriately connected with actors outside the farming system) has been very low within the system, due to the exiting of many stakeholders from the system and the depletion of reserves. The system has been forced to reorganize and form new connections. It can thus be said that this general resilience attribute is improving for the system. There is a lot of room for improvement regarding the social self-organization.

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Finally regarding 'modularity', the spatial and temporal heterogeneity (Cabell & Oelofse, 2012) was scored low in relevancy for the resilience of the system. The spatial and temporal heterogeneity used to be high for this farming system but recently the system is moving towards a more homogeneous situation. The optimal redundancy of the system has been very high. This is often argued as to decrease the efficiency of the system (Cabell & Oelofse, 2012).

<u>Constraining attributes</u>:

When looking at the diversity in responses towards challenges, it can be concluded that the system is lacking response diversity. Most strategies focused on either scale enlargement or modernization. It seems that the system has been decreasing its diversity in farm types over the last 20 years by specializing and intensifying their means of production. Furthermore, regarding the *diversity of policies* as very relevant for the system, currently there is a lack in diverse policies and policies that support the provision of public goods. The lack of diverse policies is even more important in this farming system that is highly dependent on subsidies. The system changed when decoupled payments entered into force, indicating that there is a lack of diverse policies. As Meuwissen et al. (2019) , that if this attribute is highly implemented it means that there is a safe and stable environment in the farming system wherein there is room for experimentation. The strong response of the system following the changes in the CAP payments, indicate that there was no safe and stable environment. Thus, it is likely that there is a strong lack of diversity within the policies.

The attribute "supporting rural life" is currently going through a strong decrease. Many people left the countryside, and as an effect of that many of the available services are no longer available to people. People moved to the cities in search of a better quality of life. Also, there has been a long trend of ageing of the countryside. It can thus be concluded that the system is especially low on system reserves. It has been relying on its reserves for the last 20 years and this led in some cases to a collapse. Many farmers and other stakeholders were forced to exit the system. It might be possible that the complete depletion of the system reserves, forced the system finally to reorganize and to change its course. This might indicate that the system is currently, albeit slowly, rebuilding its reserves.

Regarding the modularity, in the last 20 years, about 50% of all ovine farms disappeared from the region. It might thus be that through to the high levels of redundancy the system managed to survive. Along with the population decrease, the high number of exiting farms led to several problems in the region, such as land abandonment and more likely forest fires. Furthermore, the lack of services in the rural areas becomes an increasing issue. These examples indicate that the systems modularity has finally reached a point whereby it is harmful to the system when farmers exit. This strongly indicates that the modularity of the system is not optimal (Meuwissen et al.,

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2019). It can be concluded that the systems modularity decreased from very high to very low within 20 years. Recently the trend of exiting farmers has slowed down a bit.

5.7.3 Concluding remarks on attributes

At the system level, the performance of the resilience attributes is relatively poor with regard to each process (farm demographics, agricultural practices, risk management and governance) (Table 5.2). This implies that the general resilience is at a relatively low level in Huesca.

Table 5.2. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Mixed farms with diverse functions (AP, FD)	Low response diversity (RM) Lack of diversity of policies	Multi skill farmers providing different functions (AP, RM)	Unequal distribution of the policy aids among sectors with different profitability (G)
Openness	Low exposure to market disturbance (RM)	Lack of policy instruments to open the sector (G) Lack of interest in investing in innovation due to the low profitability (FD, RM, G)	Open-minded to adapt (RM)	Lack of confidence in the future of the sector (RM)
Tightness of feedbacks	Cooperatives and farmers' organizations; Geographical Protected Indication (FD, AP)		Engaged in networks, exploring collaboration (G, RM)	Lack of confidence on other farmers-cooperatives (FD, RM)
System reserves	Policy instruments on buffer resources (G), Coupled with natural resources (AP, FD)	Low profitability (AP), Low skilled people (FD) Limited pasture access (G) Low social services (G) Low rural population (FD, G) Loss of knowledge (FD) Lack of financing products due to the low profitability of the sector (RM)	Willing to learn (RM) Strong commitment with the sector and rural areas(FD)	Loss of knowledge (FD) Lack of attractiveness (FD) Lack of earnings (RM) Lack of confidence on the future of the sector and the support of institutions and other actors (FD)
Modularity		Reduced number of farms and farm types (FD) Limited spatial and temporal heterogeneity (FD, AP).	Reflexivity, experimenting (AP, RM)	Low number of farmers to collaborate with in taking care of the herd (FD)

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5.8 ADAPTIVE CYCLE

The previous resilience assessment allows us to place the farming system in the adaptive cycle. The sheep extensive farming system in Aragon is in the collapse phase. The essential functions indicators show downward trends, the resilience attributes show poor performance, the robustness of the sector as well as the policy support to robustness is weak and the strategies implemented by the remaining farmers contributes to adaptability capacity towards the reorganization phase.

Regarding the *agricultural* production cycle, the farming system has been very production oriented over the assessed period, even though the system encountered many challenges limiting the production. As the openness of the system increased, it started to deplete its reserves as a strategy. The system went from a conservation phase, towards a collapse and in more recent years into a reorganization phase. About 50% of the farmers finally exited the system during the collapse, but the agricultural production did not decrease as much because the remaining farmers reorganized themselves into more intensified and more productive systems.

About *farm demographics*, one of the most challenging problems of the area is exiting of the farmers from the sector moving to other more profitable specializations, such as intensive livestock production or irrigated crops. This phenomenon is accompanied by a depopulation process. Although the number of farmers has deeply decreased over the last 20 years, it is still expected that more farmers will leave the sector. Those who remain in the sector are in a reorganization phase oriented to increase the size of the herd and reinforce the level of technology in the farm management.

The *governance* of the extensive farming system seems to be in a collapse phase. Some of the CAP instruments implemented by the national and regional government, such as the payments based on the historical payments and hectares and the low payments coupled to production, seem to constrain the resilience of the sector. Policy instruments do not incentive and reinforce the public good provision of the extensive farming, much less profitable than other agricultural sector. There not have been support enough form the Pillar II and rural development of the region.

The *risk management* cycle proved not to be strong enough to prevent the other processes from falling into a collapse. However, risk management together with agricultural practices allows the farming system to initiate the reorganization phase after the collapse. Farmers in the sector implement new risk management strategies to cope with future perturbations (for example by reinforcing the collaborative actions).

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In literature it is argued that a pitfall for resilience is when all main processes find themselves in the same phase (Folke et al., 2010; Resilience Alliance, 2010). This is largely the case for this farming system. Most processes are in the collapse phase currently.

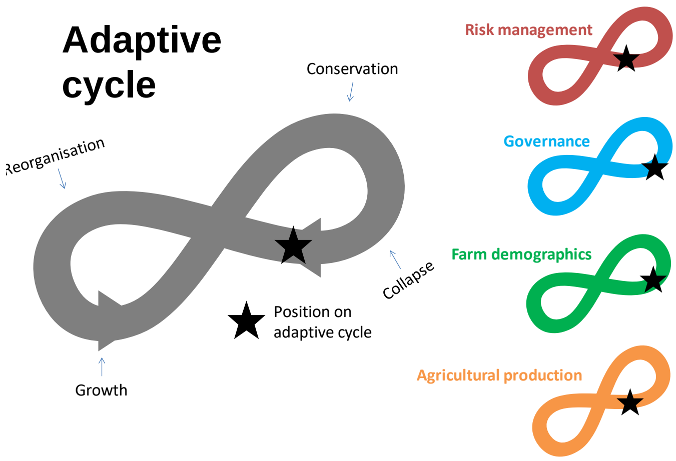

Figure 5.11. Positioning the farming system in Huesca on the adaptive cycle of processes in agriculture.

5.9 STRATEGIES

Many of the strategies indicated by stakeholders contributed stronger towards adaptability than robustness or transformability (Table 5.3). This is likely since the system finds itself largely in a reorganization phase in the agricultural practices and risk management dimensions, in which adaptations need to be made.

Table 5.3. Future strategies per process.

Process	Future strategies
Agricultural production	- Animal handling technologies - Consumer oriented strategies - Introduce new rainfed/irrigated crops varieties - Feeding extensification (transhumance)/ Feeding Intensification (new and cheaper feed products)
Farm demographics	- Support the training and knowledge sharing. - Facilitate contact between exit-entrant farmers. - Enhance the young and women entrance. - Enhancing the attractiveness of remote areas and farming. - Stimulating succession via easier access to land
Governance	- More equitable aids distribution - Support the provision of public goods. - Enhance transformability (processing and retail activities) - More attention to gender issues - Public awareness about the extensive farming and its contribution to environment conservation.

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Risk management	- New insurance for new risks (diseases) - Improved grasslands insurance - Financing products adapted to farmers' needs. - Training, information and cooperation to deal with risks

5.10 CONCLUSION

The aim of this report is the assessment of the current resilience of the sheep extensive farming system in La Hoya de Huesca (Spain). The assessment relies on the main findings gathered in a wide and diverse set of activities performed in the region: i) qualitative approaches, such as demographic and learning capacity interviews, FoPIA-SURE-Farm and ResAT workshops, risk management focus group; and ii) quantitative approaches to address the ecosystem services. The assessment follows the resilience framework proposed by Meuwissen et al. (2019): resilience of what (farming system); resilience to what (challenges), resilience for what (essential functions), the resilience capacities and what enhance resilience (resilience attributes). Finally, the findings allow us to identify the position of the farming system in the adaptive cycles considering four dimensions, agricultural production, farm demographics, risk management and governance.

The farming system is made up of seven actors with mutual dependence with farmers: famers households, crop farmers, veterinarians, cooperatives, farmers' associations, distributors, local public services and research centers. There is a clear consensus at farm and farming system level that the main essential functions of the farming system are to ensure enough farm income and deliver of high-quality food products. The provision of public goods such as ensure animal welfare and maintain natural resources are also important functions of the system. The perceived relevance of the provision of public goods of the extensive sheep farming has been increasing over the last years. The farming system's actors consider that the relevance of the positive contribution of sector to the environment is almost the same than that of food production. The indicators of the provision of private goods show a downward trend during the last 20 years. No adequate indicators exist to measure the provision of public goods. Farming systems actors claim that the public services provided by the extensive farming system have showed a good performance over the last years, though they could no longer remain if the number of ewes keep diminishing in the farming system.

Farmers and farming system have been mainly facing long-term economic and social and institutional challenges, referred to the structural low profitability of the sector, the low attractiveness of the sector and the insufficient aids systems. Long term environmental challenges and shocks are perceived to a greater extent as future challenges. Environmental shocks as wild fauna attacks and droughts are one of the main concerns for the farmers. The strategies

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implemented in the sector strongly focus on improving adaptability, moderately focus on robustness and in a lower extent to transformability.

The performance of the most relevant resilient attributes in the farming system i.e. reasonable profitability, support rural life, diverse polices, coupled with local and natural and socially self-organized has been relatively poor, and not contributed as required to the processes of farm demographics, agricultural practices, risk management and governance. Policy goals and instruments have not been able to properly support the provision of private goods nor to enhance the provision of public goods. This leads to conclude that the general resilience is at a relatively low level in Huesca

The resilience assessment allows concluding that the sheep extensive farming system in Aragon is in the collapse phase in the adaptive cycle. It is hard to conclude if the system reached its lowest point. Farming systems do not always follow all the phases of the adaptive cycles (van Apeldoorn et al., 2011), and it might be possible that the system will further collapse when new challenges present themselves.

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6 CASE STUDY SWEDEN

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6.1 ABSTRACT

This report synthesizes findings from the first two years of the SURE-Farm project for the Swedish egg and broiler production case study (Figure 6.1). Different research activities have investigated farm level and farming system level challenges, opportunities, essential functions, as well as resilience capacities and attributes. Major challenges, as perceived by various stakeholders, are power imbalances along the value chain, changing consumer preferences, extreme weather events, strict animal welfare and other regulation, succession and social life. Among the mentioned opportunities are greater cooperation among chain actors, policy support to adopt new technologies, and improved lobbying and communication. Stakeholders perceive the main essential functions of the farms/farming system to be food production and income generation, both representing private goods, and quality and attractiveness of rural life and maintaining natural resources in a good condition representing public goods. In the demographic interviews farm succession and income source diversification (off-farm and on-farm) were mentioned as important for resilience. Technology adoption was viewed as a key strategy for adaptation.

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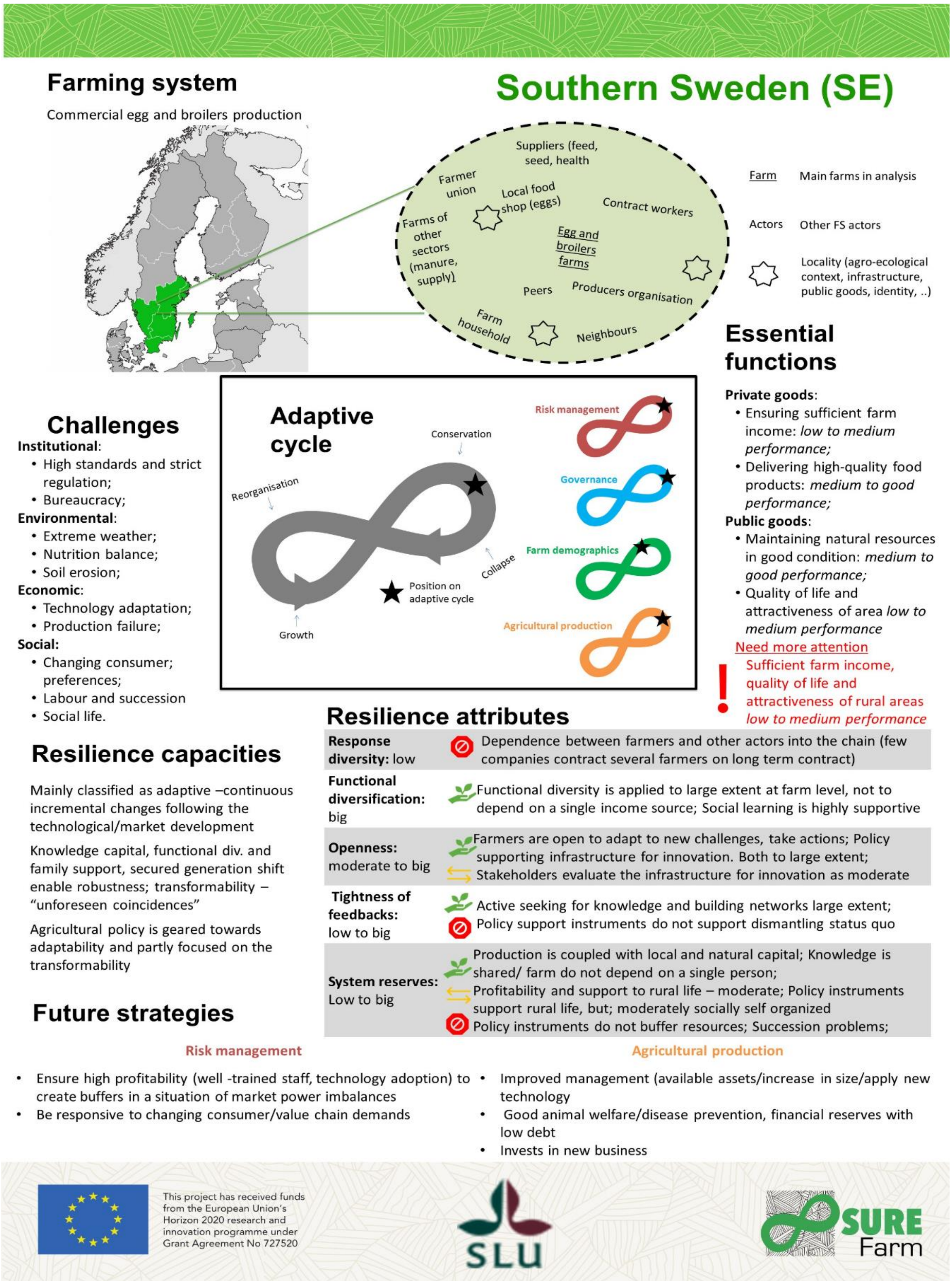

Figure 6.1. Factsheet synthesizing resilience of the current faming system in the Southern Sweden.

6.2 FARMING SYSTEM

Historically, egg and broiler production in Sweden has been located in the plain districts of the Southern part of the country. The region is recognized for its agricultural activity. The case study region comprises of five (out of eight) of the Swedish NUTS-2 regions, namely SE11 – Stockholm, SE12 – Östra Mellansverige, SE21 – Småland med öarna, SE22 – Sydsverige, and SE23 – Västsverige. Although the landscape and the soil quality are heterogeneous, the region is highly recognized for its fertile plain districts especially in the SE12, SE22 and SE23 regions where cereal production dominates the agricultural sector (45% of the country's total in 2018 (Eurostat, 2018). While it occupies approximately one third of the total area, 85% of the utilized agricultural area and 75% of the agricultural holdings registered in Sweden belonged to this region in 2016, (Eurostat, 2018)).

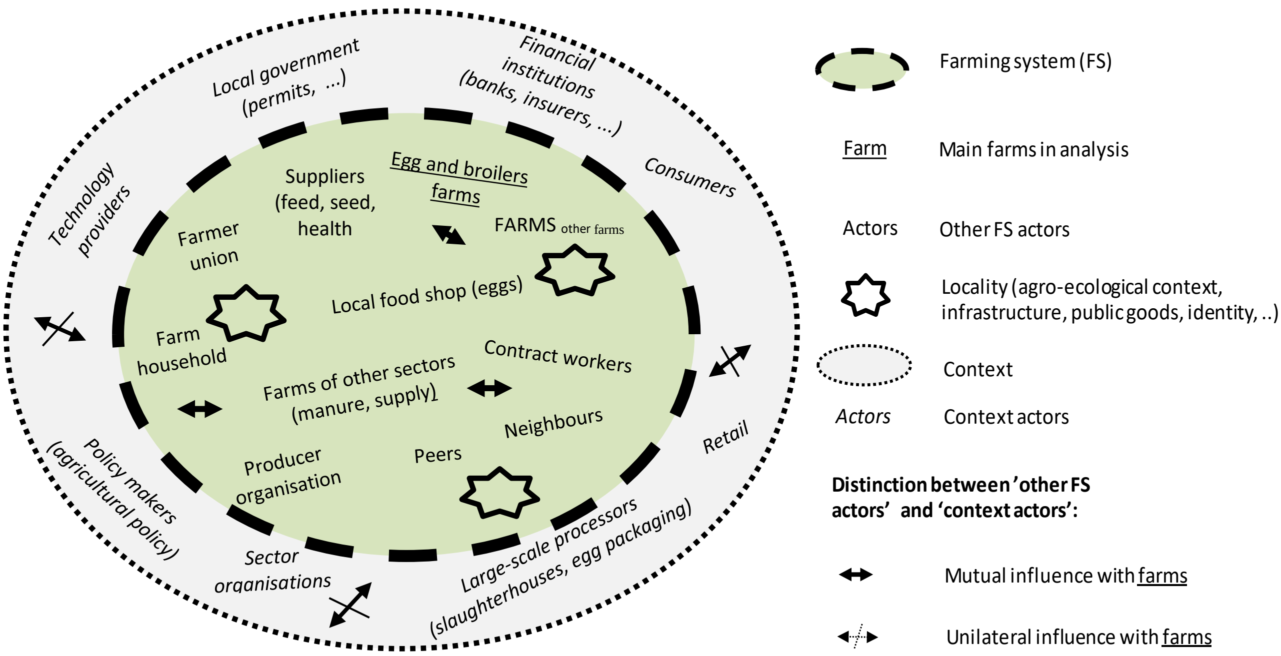

Figure 6.2. Visualization of the actors characterizing the farming system.

A visualization of the actors who are part of the farming system is provided in Figure 6.2. The discussion with the FoPIA-SURE-Farm workshop participants led to the conclusion that the farmers' union, producer organizations, input/feed suppliers, farm households, contact workers, peers, neighbors, and farms from other sectors are among the actors of the first inner circle, having mutual influence with the egg and the broiler farms. Stronger links between farmers/farming union/producers organizations were discussed with the aim to strengthen lobbying vis-à-vis policy-makers and authorities. It was also discussed that large-scale processors (slaughterhouses, packing houses) ideally should belong to the inner circle, but farmers perceive

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their mutual influence as imbalanced. Farmers often depend on a single processor, whereas processors face a rather fragmented landscape of smaller producers and do not depend heavily on the single farm. Processors also operate in international markets and have the possibility to by-pass local farms (e.g., by importing organic eggs from Finland). The importance of local food stores/direct sales was different for the egg and broiler producers; local food stores/direct marketing on farm are of greater importance for the egg producers, because of greater demand and because of the greater ease of selling a final product. Slaughtering and cooling needs make direct or local marketing more difficult in broiler production. Retail and consumers also belonged to the group context actors, as consumers indirectly affect the sector's decisions quite substantially (demand for organic eggs, demand for poultry meat, and views on animal welfare).

6.3 CHALLENGES

6.3.1 Present challenges for farmers and farm households

In the farm survey, respondents were asked to score challenges on a seven-point scale (1 = not a big challenge; 7 = very big challenge). Respondents scored economic challenges the highest (e.g., Mean (M) = 5.4, Standard deviation (SD) = 1.5 for high input prices; M = 5.6, SD = 1.5 for low output prices; M = 5.7, SD = 1.6 for low bargaining power). Among the environmental challenges, extreme weather events (M = 5.1, SD = 1.6) and diseases (M = 4.7, SD = 1.6) were the main challenges. As one would expect, soil quality (M = 2.9, SD = 1.7) did not pose a major challenge, as egg and broiler farms do not necessarily rely on on-farm land for fodder production. Limited availability of skilled labor (M = 4.7, SD = 1.7), strict regulation (M = 5.5, SD = 1.7), and low societal acceptance of agriculture (M = 4.7, SD = 1.9) were among the most important social and institutional challenges as indicated by the farmers. Further explorative analysis could study differences among organic and conventional production as well as differences between the egg and the broiler producers, but the sample size is too small (n = 64 with many missing variables)to allow very strong conclusions.

Challenges identified in the learning and demographic interviews with the farmers are various economic, environmental, institutional and social challenges. The economic challenges, as explained by the farmers, were related to market prices, interest rates, economic loss from production failure, and diseases. For instance, informants pointed out that there is no level playing field when it comes to competition with farms from other European countries. Farmers also believe that Sweden has higher production costs due to much stricter animal welfare standards. Yet, imported chicken meat produced under much lower animal welfare standards is sold at lower prices on the Swedish market. It should be noted that in this project we have not investigated the real impact of animal welfare regulation on competitiveness (or costs and revenues). The scientific literature in this respect is thin. Egg producers stated that they face increases in fodder prices

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(while egg prices remain unchanged and are generally not strongly correlated with fodder prices). This could lead to high risks and low profits.

Weather conditions were mentioned as the main environmental challenge, primarily covering issues related to the recent heat waves and climate change. However, heavy rains and storms can damage crops in the fields as well. The periods of drought in Sweden in the summer 2018 has led to low yields and harvests, resulting in both increased crop prices and a shortage of fodder among the farmers. The low levels of rainfall in the past few years have resulted in low levels of ground water in several places, which becomes problematic, as farmers are highly dependent on this water. Heat risks were further discussed in the context of decreased animal welfare (as the hens and chickens suffer from hot stables), lower intake of food and water, greater risks of a spread of pathogenic microbes (and related animal diseases), lower quality eggs (as increased heat in the stables tends to result in more hens laying their eggs on the floor, where it is colder, instead of the egg-laying compartments designed to keep eggs undamaged and clean).

Institutional challenges relate to bureaucracy, powerful authorities, and animal welfare orientations of civil society and activists. A high dependence on the goodwill of administrative bodies and risks related to changing regulations were repeatedly brought up in the interviews. The increased administrative burdens that farmers perceive lead to a greater work load and hence increase costs. Animal rights activists were classified as a source of risk, influencing consumer demand, but also as potential transmitters of animal diseases following illegal entry into stables. If unauthorised persons enter the stable without proper disease preventing measures, this could lead to the culling of all animals, resulting in considerable losses for the farmer.

Social challenges relate to (1) the difficulty of finding qualified labor, willing to work on a farm and willing to accept the high work load, (2) gender issues obstructing the farm succession process, as well as the production process, (3) personal challenges related to illness, divorce etc.

6.3.2 Present and past challenges for the farming system

Challenges at the farming system level were analyzed with the ResAT tool and the FoPIA-SURE-Farm workshop. Given the results from the ResAT tool, the study region faces various environmental (nutrient balance, soil erosion, climate change), economic (different standards for domestic and imported products, high production costs, changing consumers preferences, low level of value added at farm level; banks and investor shy away from providing loans/capital for investments that would lead to a greater share of value added at farm level), institutional (strict regulation, standards), and social challenges (age, gender structure, lack of skilled/educated workers, farm labour characteristics, social life). The FoPIA-SURE-Farm workshop participants discussed challenges that have been present over the past 10 years. The main topic of the

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discussion was the need for technology adaptation, namely the pressure for conversion to organic production of eggs and broilers as an example. Also knowledge management and investment in new technologies were brought up.

6.3.3 Concluding remarks on challenges

The summary of challenges identified ad at farm- and faming system level, across 4 dimensions environmental, economic, social, and institutional is presented in Table 6.1.

Across the methods, environmental, economic, social and institutional challenges are similar. However, the FoPIA-SURE-Farm workshop identified fewer challenges in comparison to the other methods. Except for institutional challenges, shocks were hardly identified at farming system level, but were present at farm level (related to climate conditions, diseases, illness and divorce), especially from data collected by demographic/leaning interviews.

Table 6.1. Summary of challenges across methods. Synthesize of all methods across 4 dimensions (environmental, economic, social, and institutional) and 2 types (farms and faming systems).

			Environmental	Economic	Social	Institutional
Farmers		Ranking of challenges based on the farm survey	1. Persistent extreme weather events (e.g. floods, droughts, frost) (high) 2. Pest, weed, or disease outbreaks (high) 3. Low soil quality (low)	All high with very high scores for 1. low bargaining power towards processors 2. low market prices Somewhat lower scores for 3. Input price fluctuations 4. Output prices fluctuations	1. Reduction in direct payments (rather low)	1. Strict regulation (very high) 2. Low societal acceptance of agriculture (high) 3. Limited labor availability (high) 4. Public distrust in agriculture (medium)
Farmers	Shocks	Learning interviews Demographic interviews	• Drought • Heavy rain	• Economic loss from production failure • Diseases	• Illness, • Divorce	• Animal welfare activists
Farmers	Long-term stresses	Learning interviews Demographic interviews		• Market prices • Interest rates • Demand change • Technology adaptation • Different standards for domestic and imported products • Access to capital • Scandals	• Work load • Qualified labor • Labor willing to work on a farm • Succession • Gender issues • Social life	• Bureaucracy • Powerful administration • Animal welfare activists • Strict roles
Farming system	Shocks	FoPIA-SURE-Farm ResAT				• Strict roles to prevent risks • High standards to prevent risks
Farming system	Long-term stresses	FoPIA-SURE-Farm	• Technology adaptation • Knowledge management	• Technology adaptation • Knowledge management		

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ResAT	• Nutrient balance • Soil erosion • Climate change	• Different standards for Swedish and EU products • High production costs • Changing consumer preferences • Low level of value added at farm level • Creditors do not support projects for high value added products	• Labor renewal • Gender structure • Lack of skilled/educated workers • Social life • Changing consumer preferences	• High standards and strict regulation

6.4 OPPORTUNITIES

6.4.1 Present and past opportunities for the farmers

The learning interviews revealed farmers' entrepreneurial spirit. Farmers are also often open to new ideas and aware of the fact that one must deal with changing conditions and challenges in agriculture. This mind-set affects farmers' views of past and future challenges. In one way, farmers appear to be well prepared for new challenges, as they have already successfully dealt with challenges in the past, often showing great creativity. But then again, we only spoke to farmers who are still farming, and there could be survivorship bias in this perspective if we consider the system as a whole. From the demographic interviews it also became clear that in some cases the entrepreneurial spirit drives the transformability of the farm.

6.4.2 Present and past opportunities for the farming system

In the different SURE-Farm activities there was a small set of recurring issues: (1) animal heath, (2) consumer preferences, (3) strict regulation and high standards, (4) low profitability often directly attributed to low bargaining power and market imperfections. For each of these issues opportunities were discussed, and the issues are also strongly interrelated. For instance, although animal health is perceived to be challenging, farmers also feel quite confident about their knowledge and practices in dealing with animal health as part of their day-to-day activities. Often the larger problem at hand is not solved through a quick technical fix or caused by a knowledge gap at farm level. There could rather be a lack of awareness from consumers or policy-makers (farmers feel portrayed wrongly by the media or activists; they must follow very strict regulation etc.).

Opportunities exist in marketing at a sectoral level. Especially in the egg sector, the demand and willingness-to-pay for premium products has been good and stable over the past years. Regulation for public procurement for school canteens etc. will probably include demands on greater shares

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of high animal welfare standard, local and/or organic production for many products, including eggs and chicken meat. Farmers should not miss out on these opportunities and utilize them to realize greater margins than they do now. As of now, the largest share of the value added remains with the processors and retailers. Improved communication and involvement in product innovation through greater networking efforts among farmers and their sector and producer groups/organization appears to be promising in this respect. The organizations and networks perform very well when it comes to emergency short-term support in times of acute crises (e.g. bird flu), but there is some room for improvement with respect to a greater emphasis on the long-term/strategic development of the sector. Here, sector organizations could still play a greater role as a catalyst. Ultimately, a level playing field for all market participants should be ensured by regulation and administrative action. Farmers currently view the system as working against them, often neglecting fair competition as precondition for efficient markets.

6.5 FUNCTIONS

6.5.1 Farmers and farm households

The farm survey revealed that ensuring a sufficient farm income and delivering high quality food products are the two most important functions (with similar scores), followed by ensuring animal welfare (Figure 6.3). Biodiversity protection and the provision of bio-based resources were among the lowest scoring functions.

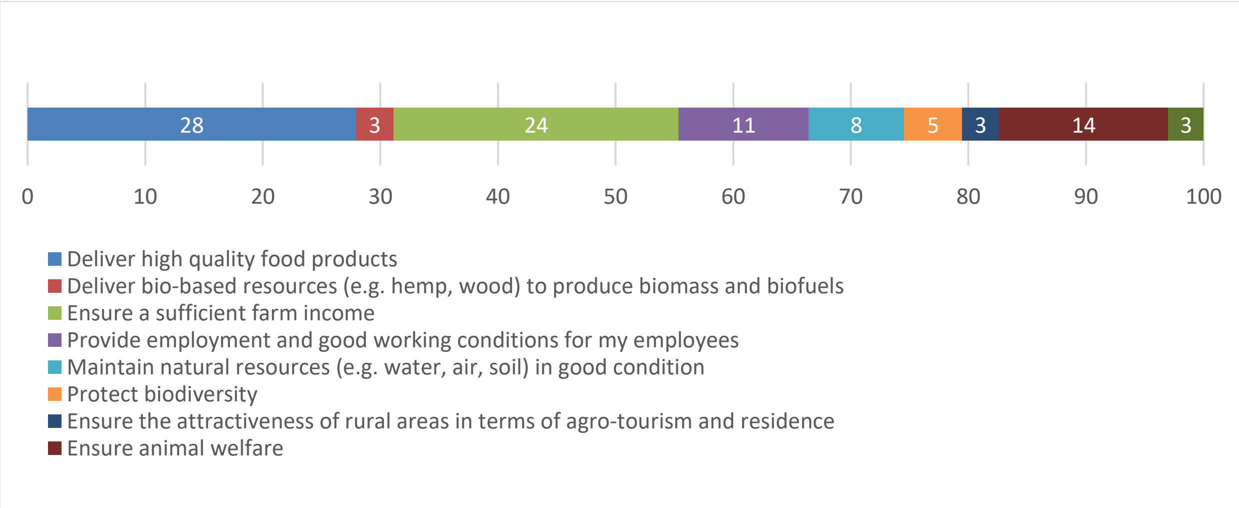

Figure 6.3. Essential functions (average percentage of allocated points) according to the farm survey.

The learning and demographic interviews showed that planning the production, while ensuring sufficient profitability appeared to be the most important function. For some farmers providing good working conditions for the employees, with a possibility to advance knowledge and receive additional training, was also of great importance. Ensuring good animal welfare was mentioned

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as necessary for ensuring the economic stability, avoiding risks from diseases etc. Delivery of other public goods functions was rarely mentioned. Also note that animal welfare was not necessarily viewed as public good by all farmers, as animal welfare could also affect the quantity and quality of produce, as well as costs and revenues.

6.5.2 Farming system

Insights on the essential functions (EF) for the farming system were obtained from the FoPIA-SURE-Farm workshop. The bubble graphs in Figure 6.4 and Figure 6.5 present the average scores on performance of EF and performance of the indicators respectively, indicating their importance (given the size of the bubble) relative to each other.

Across the EF, "food production", "economic viability", "natural resources", as well as "animal health and welfare" were identified as most important EF (Figure 6.4). Although highly important, the performance of "economic viability and "animal health and welfare" was considered as medium. "Bio-based resources," "quality of life," and the "attractiveness of countryside" received the lowest scores of both performance and importance.

Among the indicators, "product price," "profit per m²," "price of fodder and energy," "work load," and "access to public services" were given the lowest performance scores (below 3) from all stakeholder groups. Among these indicators "product price" and "profit per m²" were considered as highly important. In contrast, the best performance scores (above 4) from all stakeholder groups were given for the "total production" volume, "salmonella control," "fulfilment of the criteria for animal welfare," "animal health control," "GHG emissions," and "employment possibilities." "Total production" and "fulfilment of the criteria for animal welfare" are among the indicator with high importance for the system.

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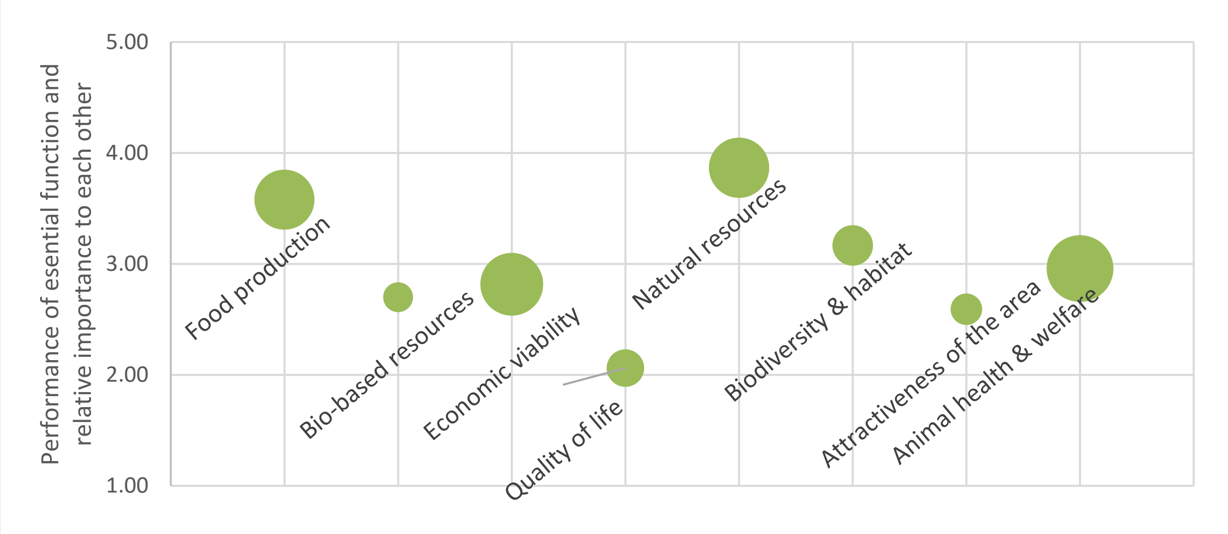

Figure 6.4. Bubble graph presenting average scores on performance of essential functions (from 1 - not at all to 5 - very large extent), while also indicating their importance (size of bubbles) relative to each other. Assessed by stakeholders in the FoPIA-SURE-Farm workshop (n = 6).

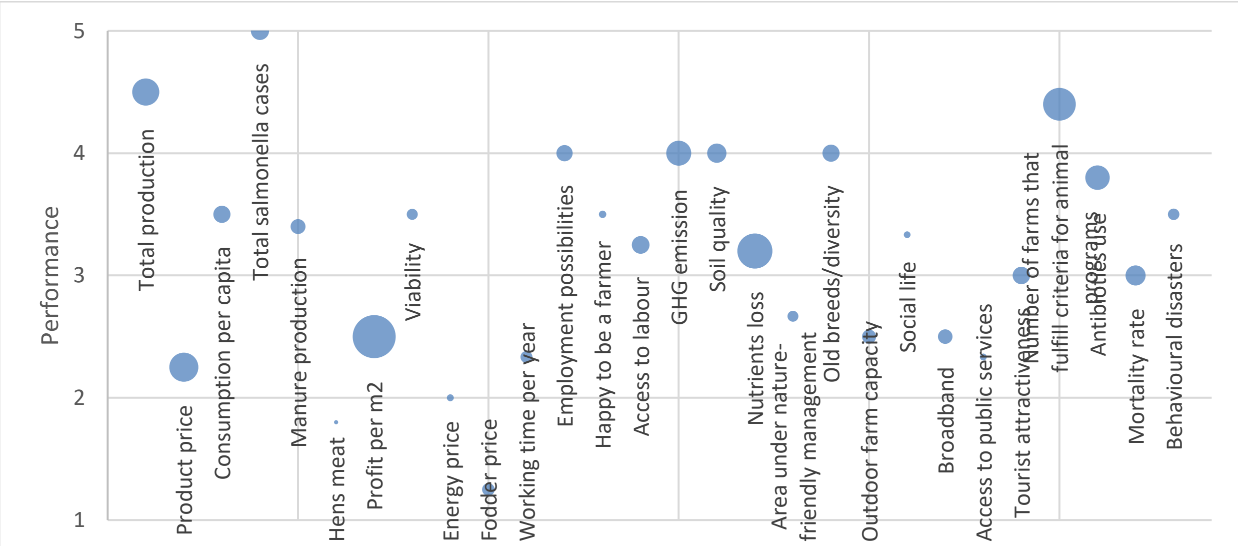

Figure 6.5. Bubble graph presenting averaged scores on performance of indicators (from 1 as not at all to 5 as very large extent), while also indicating their importance (size of the bubbles), relative to each other. Assessed by stakeholders in the FoPIA-Sarm workshop (n = 6).

The ecosystem services (ES) assessment shows that compared to other EU regions, the current performance of food production and private goods is low (at a regional level). Timber removal and energy crop production perform best with values approaching 0.25 on a scale from 0 to 1. (Figure 6.6). The performance of all the remaining private goods is very low (<0.1). Most probably, this is due to high share of forest (only 17% of the area is agricultural land). As a consequence, the total output of private goods is low compared to other EU areas.

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The ecosystem services (ES) assessment for public goods (Figure 6.7) shows the highest value for avoiding soil erosion (~1). The habitat quality based on common birds and a water retention index are the second and the third best (~0.5), followed by carbon storage (~0.4) and NO_x retention capacity (~0.3). The performance of other services is low (0.0 to 0.25) with a particularly low pollination potential (<0.1). The high value for the capacity to avoid soil erosion can be explained with the fact that in Sweden, soil erosion is a problem mainly in the coastal areas (especially in south/west Sweden), which is a very small part of the total area of the farming system. On the other hand, the very low pollination potential can be explained by the rather intensive crop farming methods.

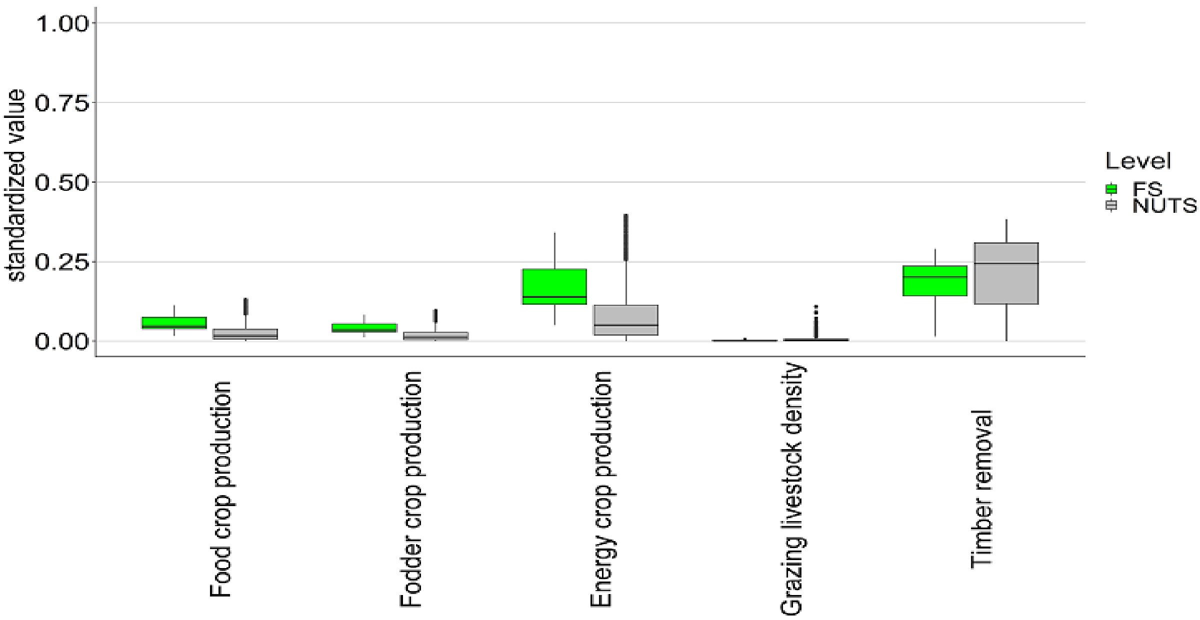

Figure 6.6. Sweden, farming system level. Current performance of ecosystem services related to private goods according to the ES assessment.

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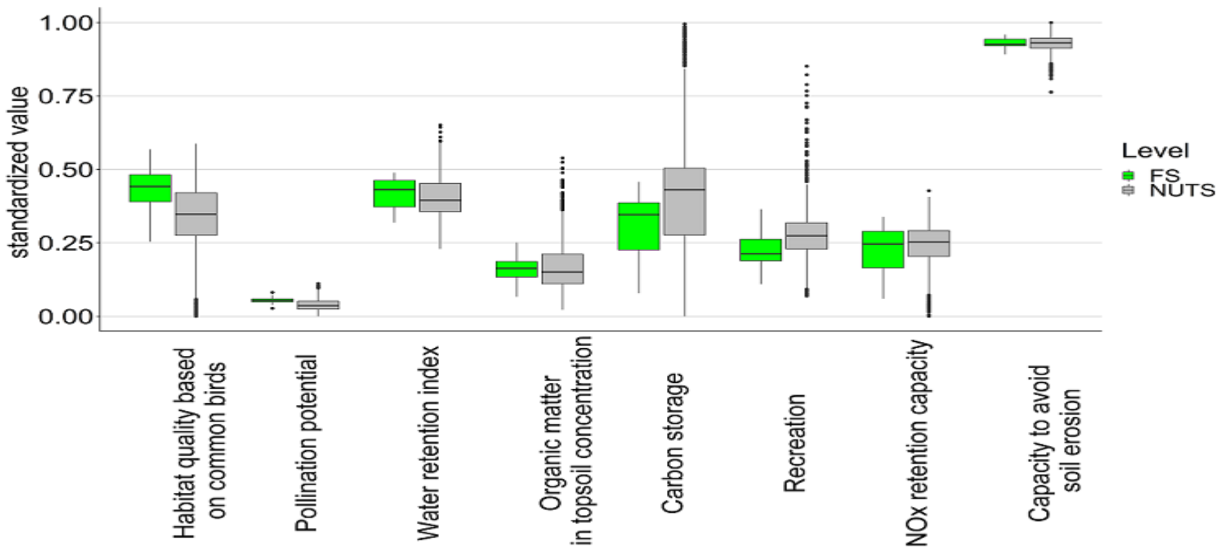

Figure 6.7. Sweden, farming system level. Current performance of ecosystem services related to public goods according to the ES assessment.

6.6 RESILIENCE CAPACITIES

6.6.1 Farmers and farm households

At farm level, based on the farm survey, robustness (M = 3.74; SD = 1.65), adaptability (M = 3.91; SD = 1.70), and transformability (M = 3.71; SD = 1.71) all scored similar on a seven-point scale in the survey.

In the learning interviews, farmers explained that learning is mostly related to adaptability. Typical examples are adapting to changing circumstances to meet future challenges that the farmers have identified. Farmers seek advice for instance from consultants, advisors, family, other farmers and capacity building activities (for the employees) to develop new work routines, to implement new regulation or to address challenges that require more substantial change at farm level. Many farmers are entrepreneurial minded, and they are often open to new ideas or the realisation that one must adapt to survive. Robustness has been associated with the own experience and learning by doing, as well as learning from others (other farmers, consultants and advisors in particular). Learning for transformability is not as common (present in two mini case studies) and consultants and advisors with specific expertise were identified as the central actors.

In the demographic interviews, robustness relates to family support, family labor availability, labor division (including gender issues), off-farm employment, generational shift and social networks. Good relationships to farmers in a surrounding network were also viewed as important for adaptability. Similar to the learning interviews, demographic interviews showed that functional diversification of the farm enterprise is among the most common solutions for keeping the farm

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robust. Not being dependent on a single income source was specifically mentioned. For example, shaping the activities of the farm to fit the profile of the environment (renting out recreational housing or making use of the wider consumer market found in towns and cities, forestry etc.) were some of the mentioned strategies. Following the demographic interviews, transformability of the farm was also driven by "unforeseen coincidences" that enabled the entrance/change to broiler or egg production. This could have been, for instance, an opportunity to buy a farm that was suited for the kind of production envisioned, being asked to work for a broiler or egg farm, or the main processing company approaching a farmer to join a specific type of production. In many instances, changing to organic farming was pointed out as transformability.

6.6.2 Farming systems

Following the sketches of historical dynamics by stakeholders in FoPIA-SURE-Farm, the dynamic of technology transformation over the past ten years is mainly driven by the demand for organic products (to a large extent nationally supported, via policies for organic food procurement in the public sector, e.g., for canteens in schools). According to the stakeholders, strategies applied for the knowledge development contributed to the robustness, the adaptability and the transformability of the farming system. However, capital investments in technology were expected to restrain the transformability of the farming system's resilience (Figure 6.8).

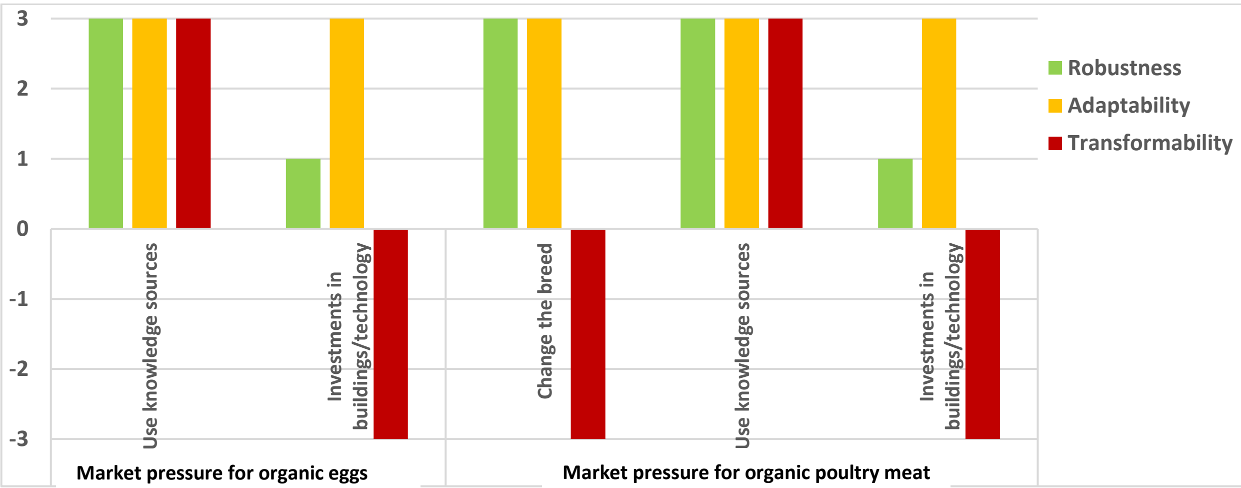

Figure 6.8. Strategies applied to cope with challenges affecting the market pressure for "organic eggs" and the "market pressure for organic poultry meat", and their perceived contribution to the three resilience capacities, from (3) as a strong positive to (-3) as a strong negative relationship. Assessed by stakeholders in the FoPIA-SURE-Farm workshop (n = 6).

Furthermore, results from the FoPIA-SURE-Farm workshop, show that the contribution of the resilience attributes on the resilience capacities is mixed (Figure 6.9), mostly showing weak (1) and intermediate positive (2) relationships. "Reasonably profitable" was found to have a strong positive (3) relationship with robustness, and a strong negative (-3) relationship with

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transformability, as it can create lock-in and a business-as-usual view that is possibly leading to an accumulation of risks in the long run. Coupling with local and natural capital (legislation) has a weak negative relationship with transformability.

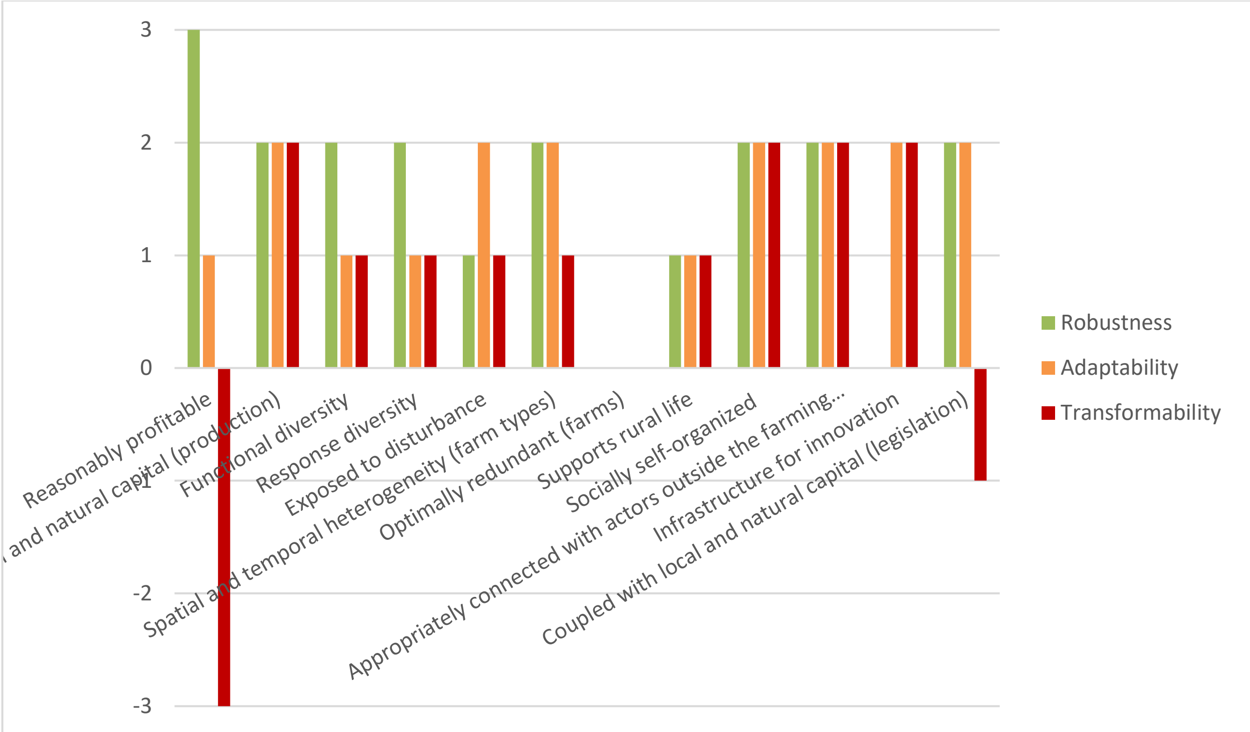

Figure 6.9. The contribution of 13 selected resilience attributes to 3 resilience capacities, from (3) as a strong positive to (-3) as a strong negative relationship. Assessed by stakeholders in the FoPIA-SURE-Farm workshop (n = 6).

The results from the ResAT exercise show that the common agricultural policy is geared towards adaptability and partly focused on the transformability of poultry production (Figure 6.10). In line with the Swedish CAP orientation towards "as long term as possible" objectives (Regeringskansliet, 2014, p. 9), with a liberal, market-oriented and competitive agricultural sector, taking into account the climate, environment and rural development (Regeringskansliet, 2014, p. 112), the policy support provided to enable the robustness of the poultry sector is very limited. Multiple policy instruments are related with the adaptability of the sector, e.g., organic production support, investment support, knowledge development and support for cooperation and pilot projects, young farmers support, support for re-structuring and modernizations of the farms, and strengthen the link between primary production and the processors etc. Main objectives are environmentally and climate-friendly practices and technologies, generational shift, flexibility and social learning. Transformability is supported via non-productive investments, support for vocational training and advisory services, support for agri-environment-climate commitments, cooperation, building innovation groups and innovation projects all with a focus on long-term social, environmental and climate objectives.

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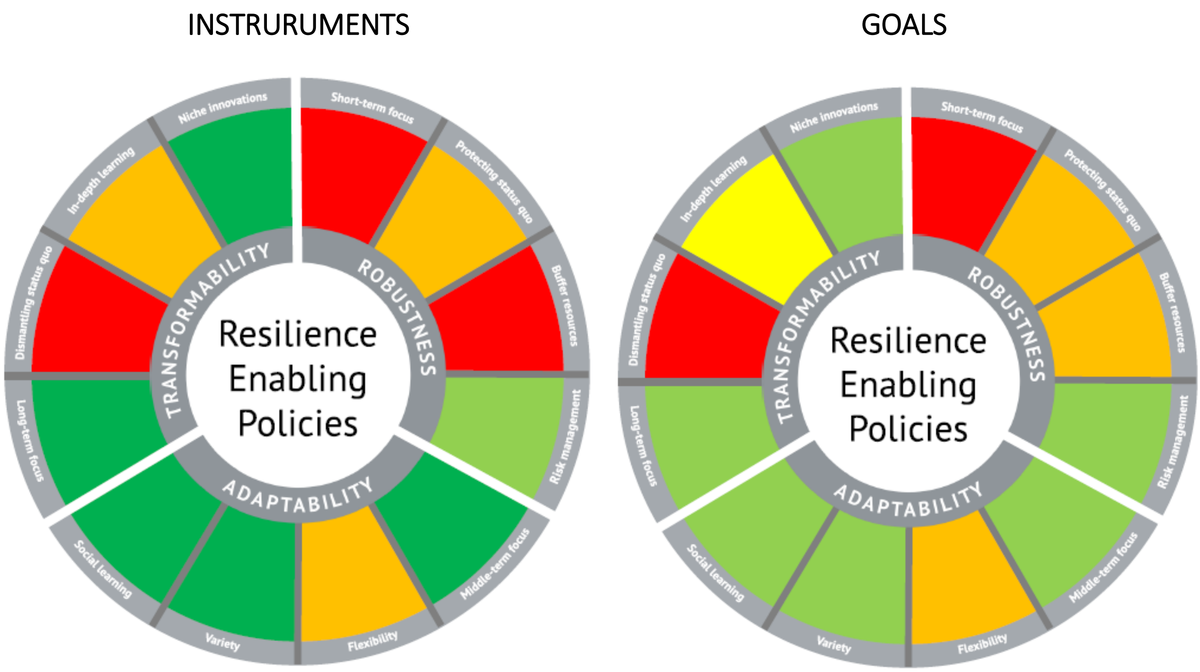

Figure 6.10. The ResAT wheel applied for the egg and broiler production farming system in Sweden. The attributes are the key characteristics for resilience-enhancing policies. The given color (+ score) indicate to what extent the key characteristic is enhancing or constraining the resilience capacity. (Red = Not enhancing or very constraining; Orange = Slightly enhancing or constraining; Yellow = Fairly enabling or fairly constraining; Light green = Enhancing or slightly constraining; Dark Green = Very enhancing or not constraining).

6.6.3 Concluding remarks on resilience capacities

The farming system seems to be mostly adaptable. Stakeholders perceived the contribution of resilience attributes highest for robustness and adaptability, followed by transformability. Policies are geared towards building up adaptation capacities in the system.

Farmers have also perceived their farms as adaptable (constant adjustments based on market requirements, legislation, etc.), but they work actively to ensure the farm to be robust (diversify income sources, maintain savings, family support, planned succession). Transformability was seen as an unforeseen opportunity driven by chance rather than a planned strategy.

6.7 RESILIENCE ATTRIBUTES

6.7.1 Farmers and farm households

Resilience attributes identified from the demographic and the learning interviews show that farmers enjoy being farmers. To secure the existence and the continuation of the farm, they seek for successors from their own family, and family labor and support is key for running a successful farm. This could be coined as a strategy aiming at ensuring high “system reserves”. “System

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reserves" can be related with strategies where knowledge is shared with everybody to ensure that the farm does not depend on a single person. Active seeking for knowledge support and building of networks ensures "tightness of feedback". Furthermore, farmers are "open" to learn from different knowledge sources and try new things, constantly adapting to the market needs and legal requirements. As farmers follow the legislation (which often is rather well aligned with objectively identified local needs and conditions) and adopt new management practices continuously, this can be viewed as a good "coupling of legislation with local and natural capital". "Functional diversity" of the farm enterprise (e.g. diversified activities such as: own fodder production, farm stores, renting houses, drive snow-track, organizing hunt, rent out fishing rights) keep the farm robust, making the farmer independent of a single income source. If the size of the farm does not allow new employment, family members seek for off-farm jobs but stay close to the farming activity, being available to help/support when needed (i.e., high "openness and modularity").

As constraining attributes, family conflicts, difficulties to find adequate successors, and gender related issues ("system reserves") were brought up. Demanding bureaucracy/authorities, and "legislation" implementation affect "functional diversity." Lack of cooperation constrains the "tightness of feedback. In the perception of farmers, activities from animal right activists play a large role as well and affect the "openness".

6.7.2 Farming system

Figures 6.9 and 6.10 show the current performance of resilience attributes as assessed in the ResAT and FoPIA stakeholder workshops. Results from the two methods differ. One explanation could be that policies are created to correct systems failures, but changes take time, or policy effectiveness is lacking.

Given the results from ResAT, policies have rather low performance for "system reserves" (short run focus, buffer resources and preserving the status quo). The performance of social learning and variety is high, which is similar to the performance obtained from the farms and households interviews, and relate on "functional diversity" and "tightness of feedback" respectively. Policy put attention on niche innovation providing possibilities for to the system to "*open*" for changes. (Figure 6.11).

The FoPIA-SURE-Farm workshop, also yielded the lowest scores for "secure reserves", represented with low profitability and support for rural life, both were ranked as slightly applied (= 2, see Figure 6.11). Relatively low "response diversity" (2) may be linked with the dependence between farmers and the other actors in the value chain, as the production is dominated by a few large chicken production and egg producing companies which contract several farmers, on long

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term contracts. Coupled with local and natural capital, functional diversity, optimal redundancy were among the attributes with the highest performance, all enabling the system to adapt to change. The precision for evaluating the attributes is rather uncertain, as some of the attributes were approached from different perspectives (egg vs. broiler production, organic vs. conventional etc.), and it is at least debatable whether these sub-sectors comprise their own system or part of a larger poultry system.

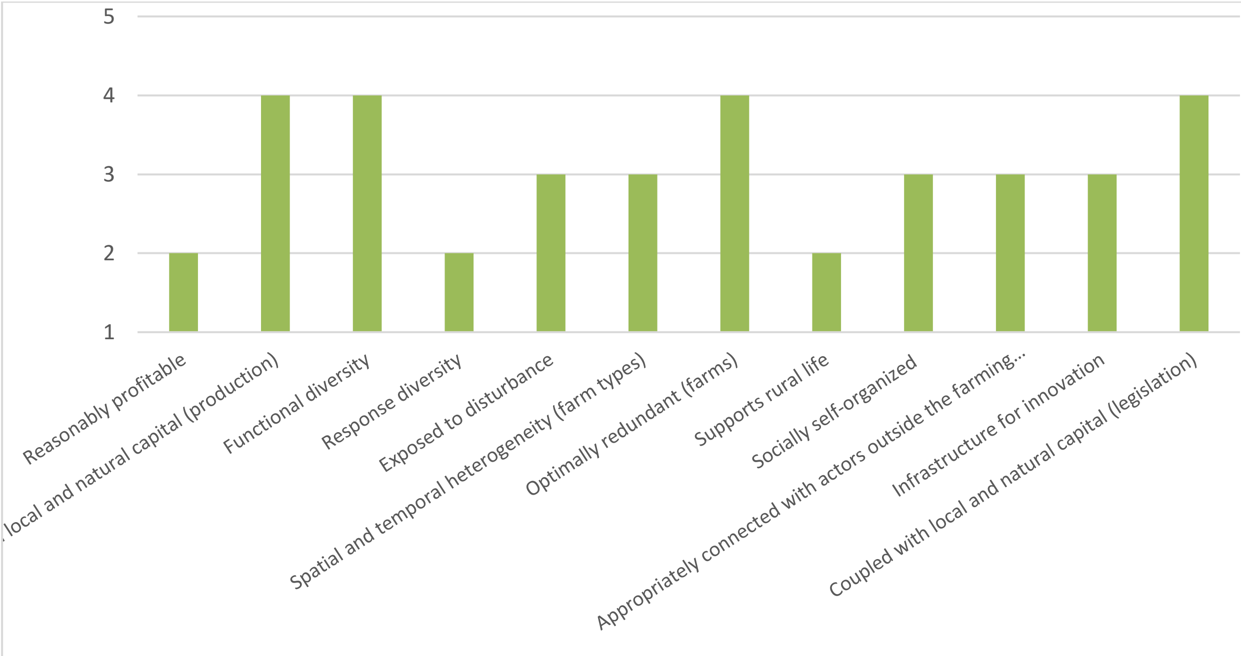

Figure 6.11. Performance of attributes on a scale from 1 as not at all to 5 as a very large extent. Assessed by stakeholders in the FoPIA-SURE-Farm workshop (n = 6).

6.7.3 Concluding remarks on attributes

Attributes characterizing the farm and household as well as the faming system follow similar patterns, but farm and household level attributes appear to perform better (Table 6.2). However, such differences could also be an artifact from different stakeholders (with different interests) participating in the various stakeholder workshop/interviews, and it would be too early to draw any general conclusions on this.

“System reserves” are at the core of the existence of many farms and the households attached to them, but the performance for “reasonably profitable,” “supports rural life” (see Figure 6.11, FoPIA-SURE-Farm) and “buffer resources” (see Figure 6.10, ResAT) have been evaluated at low levels (2). Furthermore, “openness” is highly relevant for farms and households to adapt to new challenges, whereas “exposure to disturbance” and “infrastructure for innovation” have been evaluated as moderately applied (3). However, niche innovation has a high performance from a

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policy respective (see Figure 6.11). Similarly, "tightness of feedback", seems to be a strong attribute for the farmers/household (explained by active seeking for knowledge, building of networks), whereas socially self-organized (Figure 6.11, FoPIA-SURE-Farm) and in-depth-learning (Figure 6.10, ResAT) have been evaluated as moderate (3) and (2), respectively. However, the performance of "social learning" evaluated with ResAT is high (5) (Figure 6.11). The performances of "response diversity and "coupled with local and natural capital (policy and production)" seem to be similar. The result indicates that in the future probably more collective action to maintain the currently high levels of "system reserves" will be necessary.

Table 6.2. Summary of findings on attributes across methods. Related processes are in parentheses (FD: farm demographics, AP: agricultural practices, RM: risk management focus groups, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity		Homogeneity of farm types in spite of organic and conventional, eggs and broiler (all) Low functional diversity (G)	High functional diversity at fam level (FD)	High dependence and standardization due to power of processors (RM)
Openness	Pressure from civil society (all)	High polarization, high dependence on processors (all)	Openness to change and entrepreneurial spirit combined with high robustness (RM, survey)	Fear of exposure to activists/negative views (FD, RM)
Tightness of feedbacks	Small to moderate level of self-organization, largely facilitating robustness (e.g. Svenska ägg)(G, RM)	Lack of strategic exchange between processors and producers (RM, survey, FD)		Too little engagement in networks, exploring collaboration (RM)
System reserves	Policy instruments on buffer resources and risk management (RM), Moderate level of infrastructure for innovation (AP, G), Good short-term support from branch organizations (RM)	Low profitability (all) affecting long-term reserves		Gender and family relations obstruct smooth farm succession processes (FD, survey)
Modularity		High concentration and little completion at all levels of the value chain (all)		

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6.8 ADAPTIVE CYCLE

The farming system seems to be in the reorganization phase (at least for the egg sector; broiler production appears to be closer to collapse) and continues to achieve incremental improvements. The assessment can be supported by the fairly consistent results across the various methods (demographic characteristics, learning strategies, policy, survey), showing that the farming system/farms is continuously adapting to environmental, economic, social and institutional challenges. Although partially supported by the policy analysis, transformation is not strongly desired by producers, mainly due to the high demands on investments and technology adoption, implying long payback periods and new risks. At farm level, transformability is often unpredictable and transformation is driven by unforeseen events, rather than conscious decisions. Growth of the system seems to be limited due to low profitability, the family farming character of the system, with limited possibilities for expansion both in terms of labor and agricultural area (competing with other farms in the region).

6.9 STRATEGIES

Future strategies were stated in the learning interviews and the survey and thus refer to farms/households. Farmers seek improvements by planning to either improve the management of the existing production (i.e. to build strong organization with the assets they have) or to increase the size of the farm (e.g. by buying land from neighboring farms, building new stables) (Table 6.3). Strategies for crop diversification or diversification into new businesses such as solar panel installation are also among the identified patterns. The survey identified good animal welfare and disease prevention, high savings/financial reserves in combination with low debt, working harder as key farm level strategies.

Table 6.3. Future strategies per process.

	Future strategies
Agricultural production	- Cooperation along the value chain to innovate
Farm demographics	- Attractive rural areas to address gender and farm succession issues
Farm management	- Innovation and investment support for technology adoption
Governance	- Ease bureaucratic and administrative burdens
	- Ensure fair competition (apply strict rules to imports, prevent further accumulation of bargaining power in the hand of processors or build up countervailing power)
	- Improve societal acceptance of the sector
	- More attention for gender issues (linked to man/wife entrepreneurship and attractiveness of rural areas)
Risk management	- Branding, product management
	- Manage activists, civil society views
	- Market analysis and forecast services for mid to long-term trends in consumer demand

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6.10 CONCLUSION

Egg and broiler production in Southern Sweden faces a number of challenges. For some of the new challenges it remains to be seen how they will affect the sector (e.g., changing climate). Other, more persistent, challenges continue to put pressure on farms and the farming system (e.g. low profitability, regulation).

Current system resilience is moderate to high, driven to a great extent by robustness (and to a smaller extent by adaptability). For instance, branch organizations offer good support in times of crises and farmers maintain high savings/low debt. However, at some point, the low profitability at farm level will probably take a toll with system level consequences, especially if value chain imbalances continue to grow. The potential for transformability is currently low. The pathway towards greater adaptability and greater transformability (and hence greater overall resilience) shall be led by a more integrative and cooperative approach along the value chain. Branch organizations play a key role in catalyzing the process, but policy can also enhance resilience by ensuring a level playing field of the various actors.

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7 CASE STUDY BELGIUM

Jo Bijttebier, Isabeau Coopmans, Eewoud Lievens, Erik Mathijs and Erwin Wauters

7.1 ABSTRACT

A factsheet (Figure 7.1) synthesizes the assessment of the current resilience of the Flemish dairy farming system based on SURE-Farm research applied so far. The dairy farming system in Flanders is mainly characterized by a decreasing number of farms but increasing milk production as a result of ongoing intensification and scale enlargement. Main perceived challenges include constantly changing policies and regulations, extreme weather events, low economic margins, price volatility and changing societal concerns. Ensuring a viable farm income, delivering high quality products and maintaining natural resources in good condition are considered the most important functions in the region. Performance of the first function is low, the second moderate to good, and the last moderate. More attention is needed for providing a viable income and a good quality of life for the dairy farmers and farm households, as these functions perform at a low level. Overall, the resilience of the system is low to moderate. There is a relatively high capacity to keep the status quo (robustness), while the capacity to transform is low. Current policy configurations foster robustness but support adaptability and transformability in a passive way; e.g. policies goals are well-intentioned to improving all three resilience capacities, while implementation of policy measures only results in supporting robustness of the farming system. The perceived resilience capacities of farms are farm and farmer specific. Further, the presence of attributes that enhance resilience is low to moderate. Diversity and system reserves are low; modularity, openness and tightness to feedbacks are moderate. Future strategies require that farmers are better informed about risk management strategies and alternative production systems, that policies are more stable in the context of a long-term vision, that the government organizes land availability and adoption of innovations supporting eco-efficiency, that succession is tackled at an early stage by considering alternative financing and organizational models, and that both horizontal and vertical cooperation are stimulated to improve economic viability of milk production in Flanders.

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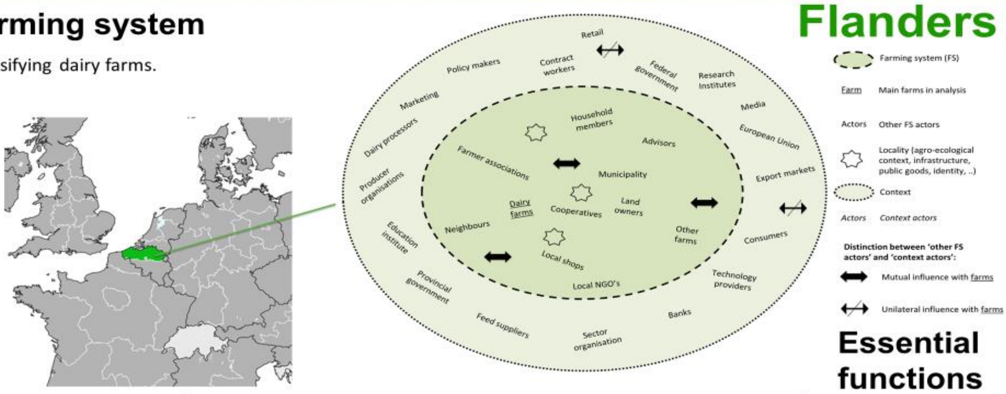
Farming system

Intensifying dairy farms.

Flanders (BE)



Essential functions

Private goods:

- Ensuring sufficient farm income: *low performance*
- Delivering high-quality food products: *medium to good performance*

Public goods:

- Maintaining natural resources in good condition, animal welfare: *moderate performance*

Need more attention

! Viable income and quality of life: *low performance*
Need for increasing attractiveness of farming as an occupation

Challenges

Institutional:

- Too severe and often changing regulations;
- Position in the value chain;
- Low availability and high prices of land.

Environmental:

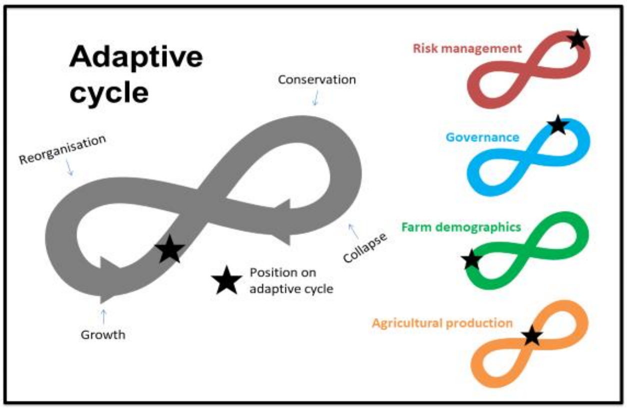
- Extreme adverse weather events.

Economic:

- Achieve acceptable profitability;
- Volatile milk prices.

Social:

- Succession;
- Societal acceptability.



Resilience capacities

Overall low to moderate resilience capacities, especially for A and T

High focus on status quo; low capacity to transform

Current policy configurations mostly foster robustness, but support adaptability and transformability in a passive way

Resilience attributes

Diversity: low	Low functional diversity, lack of diverse policies. Good diversity in farm types.
Modularity: moderate	High capacity to absorb shocks but low flexibility of farming system. High asset specificity. High dependence on value creation by processors.
System reserves: low	High soil levels of Nitrogen, but low SOC. Low profitability, low financial buffer and low succession rate
Tightness of feedbacks: moderate	Lack of policy support instruments dismantling status quo; Already high degree of horizontal cooperation, but room for improvement in both horizontal and vertical cooperation
Openness: moderate	End of quota has increased susceptibility to world market events.

Future strategies

Risk management

- Hedging
- Market information
- Financial buffer
- Technological optimization, e.g. PDF
- Better vertical cooperation and coordination

Governance

- More stable policies with long-term vision
- Accommodate flexibility and variety
- Govern land availability
- Stimulate and regulate vertical and horizontal cooperation

Farm demographics

- Govern land availability
- Tackle succession at an early stage
- Labour flexibility schemes
- (Inter)personal advice and coaching
- Alternative financing and organisational models

Agricultural production

- Precision dairy farming
- Improve eco-efficiency
- Insurance against weather events and diseases
- Increase agronomic awareness and knowledge about alternative production systems

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WAGENINGEN UNIVERSITY & RESEARCH

SURE Farm

Figure 7.1. Factsheet synthesizing the current resilience of the dairy farming system in Flanders.

7.2 METHODS

The framework developed in SURE-Farm (Meuwissen et al., 2019) was applied to assess the resilience of intensive dairy farming in Flanders. A set of activities with experts and stakeholders involvement was performed in the study region in order to feed the different parts of the resilience assessment framework. The general description of the methods were earlier described in this deliverable. This section provides information about the specific details of the activities implemented in the Flemish case study.

A total of 18 **Demographic Interviews** (divided into 8 mini-cases), with a total number of 22 respondents (in some interviews two family members were interviewed together) were performed in the study region between February - August 2018. A total of 13 **Learning Capacity Interviews** were performed in the study region in the period from August 2018 to January 2019, of which 8 interviews followed a combined interview outline of this research task and the policy bottom-up inquiry. A total of 9 **Biographical Narratives** were collected between September and November 2018. The aim of this series of interviews was to gather and analyze biographical narratives of farmers at different career stages. The open 'storytelling' interview technique allowed to gain an authentic representation of the narrator's perspective. This research task has only been conducted for 5 out of the 11 SURE-Farm case studies (Coopmans et al., 2019c). A total of 20 **Policy Bottom-up Interviews** were performed between January – March 2019.. As mentioned, time and budget constraints have stimulated the decision of conducting 8 combined Learning Capacity – Policy interviews. The policy bottom-up analysis aimed to understand farmers' and other stakeholders' perspectives on how policies influence the resilience of the Flemish Dairy sector. This analysis was additionally based on input from various sector stakeholders during the **policy bottom-up assessment stakeholder workshop**; held on September 17th, 2019 in Gent. **The Farm Survey** was finalized by 220 dairy farmers in Flanders. The **FoPIA-SURE-Farm workshop** took place in on November 27th, 2018 in Merelbeke. There were 16 participants. We had 3 homogeneous groups of stakeholders, 5 farmers, 5 industry representatives and 6 ´others´. The category 'others' included a participant from a consultancy organization, two policy makers, a veterinarian and a representative from an NGO for agriculture and food. The **Risk Management focus group** took place on June 13th, 2019 in Merelbeke. There were 12 participants around half of which were people from financial institutions (banks and insurance companies). The other participants represented advisory services, governmental institutions and the processing industry. The **AgriPoliS workshop** took place on November, 30th 2018 in Merelbeke. There were 8 participants with multiple backgrounds: Farmer, Agricultural Ministry, Farmers organization, Bank, Research Institute, Farm accountancy office. Last, the main policy instruments in Flanders were analyzed and evaluated with the **ResAT assessment tool**.

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7.3 FARMING SYSTEM

The case study in Belgium is the intensive dairy farming system in Flanders. Flanders is the northern part of Belgium, excluding the Brussels Capital Region (NUTS 2 units: BE21, BE22, BE23, BE24, BE25). It is a semi-autonomous region with a population of about 6.5 million, which accounts for 68% of the Belgian population and that covers an area of about 13,500 km^2. Geographically, the region is mainly flat. The soils are predominantly clayey and loamy/sandy. Agricultural activities in the region vary widely, with about 12% of the total farm population being dairy farms (Departement Landbouw en Visserij, 2019a).

This system is a particularly interesting case due to the recent dynamics in this sector, including, rapid structural change, a two-fold increase in the number of organic dairy farms and an increase in total milk production of almost 25% between 2014 and 2018 (BCZ, 2019). Historically, dairy farming has been very important in Flanders. Traditionally, dairy farming used to be combined with other agricultural production; typically arable farming or beef production. However, after the Second World War, agriculture gradually became more specialized. The number of dairy farms has decreased from 9856 in 2001 to 6658 in 2015; while there has been an ongoing increase in the average number of dairy cows per farm, which is currently 55 producing cows. Around 36% of the dairy farms have less than 30 cows, while 37% of the farms have more than 60 cows and 73% of all dairy cows in Flanders are milked on farms with more than 60 cows (Departement Landbouw en Visserij, 2019b).

The European market was highly protected for the last decades and milk prices were relatively stable. However, since 2007, the dairy sector has been subjected to price volatility. This is mainly due to the gradual decrease of protection measures by the CAP. In 2015, dairy quota in Europe have been abolished which resulted in an increased production of milk, quickly followed by a fall in prices (BCZ, 2017). Total milk production in Flanders exceeds national self-sufficiency. The market in dairy products is therefore strongly reliant on export. Fluctuations on the international market are therefore reflected in the milk price on Flemish dairy farms. Belgian farm-gate milk price evolution mirrors well world milk prices.

The main strategy of dairy farms in Flanders to react upon decreasing margins has been scale enlargement and intensification (higher stocking rates, more milk per input of labor, more cows per worker, more cows per ha land, more milk per ha of land) supported by relatively high external input use (fertilizer, purchased feed), automation and a trend for indoor housing and more animals per m^2 of barn. The number of dairy farms has almost halved over the last 20 years. The area in use for dairy production in Flanders, however, did not decrease. The number of cows decreased, while the amount of produced milk increased.

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The farming system is illustrated in Figure 7.2. Its boundaries are mainly determined by the regional boundaries of Flanders. Key actors of the farming system are actors who influence farmers, and, conversely, are those who are influenced by farmers.. In contrast, we exclude actors who influence the farming system, but who are themselves scarcely influenced by the system. Stakeholders did not always agree on the mutual influence between different actors. The most extensive discussion was about the cooperatives, as there was some disagreement on positioning them. Some farmers claimed that they had little to no influence on the strategies of the cooperative, other farmers claimed the opposite. Hence, there was no consensus on their position in the farming system. It was interesting to see that the farmers who proclaimed to have a strong influence on the cooperatives were those who were to some extent involved in the advisory or steering committees of the cooperative. Similarly, in some cases, the processing industry is part of the farming system, while in others not (Coopmans et al., 2019a).

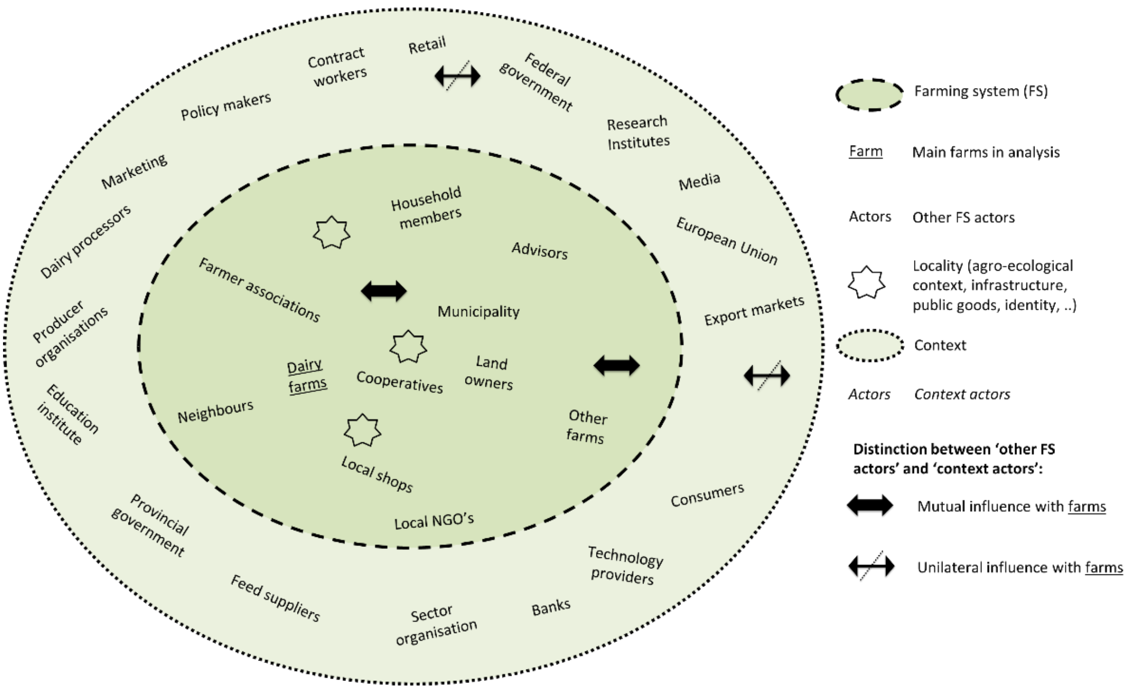

Figure 7.2. Farming system and context actors in Belgian case study area, Flanders.

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7.4 CHALLENGES

7.4.1 Farmers and farm households

Regarding **economic challenges**, survey data indicate that farmers perceive market price fluctuations (5.38) and persistently low market prices (5.55) as very challenging in the upcoming years. Milk production in Flanders used to be regulated by the quota. After a gradual decrease of protection measures from 2006 onwards, price volatility increased. Overproduction after abolishment of the quota (2015), resulted in multiple milk crises. In the interviews, low access to land was very frequently mentioned as a challenge. Competition for land, accompanied with high land prices and low availability of land, makes it difficult to acquire additional land. Even if land is available, it is often too expensive to buy as a farmer. Even if the land is rented, the owner of the land might change or the owner might decide to sell the land, which makes farmers insecure about land availability. In a region where scale enlargement is a major strategy to deal with low margins, access to land is a major challenge for many farmers.

Farmers consider strict regulations (5.38) and reduction in direct payments (5.11) as major future **institutional challenges**. These regulations are mainly the result of the negative impact of the farming system on the environment (GHG emissions, water quality, soil erosion). Manure legislation in Flanders has become more and more stringent as water quality in the region is still suboptimal. For farmers with a high livestock density, manure surplus might increase, making it more difficult to get rid of manure (increase of costs). If farmers receive less subsidies, this might be a problem, especially for young farmers who usually have a lot of debts. Farmers indicate that they need to spend more and more time on administration and paper work. Different institutions should unite to make it more doable for the farmers.

Based on the survey data, farmers' major environmental concern for the upcoming 20 years are the persistent extreme weather events (5.07). This is mainly resulting from several years of extreme drought which have affected profits in more recent years. However, based on the results from the learning capacity interviews, farmers do see **environmental challenges** as far less constraining compared to economic and institutional challenges. This can mainly be explained by the fact that they cannot control these challenges, cannot change them and nobody is responsible. Challenges that are linked to human activity (price volatility, consumer demand, policies), are more often sources of frustration. Evolution of these challenges is often a big question mark, which makes it difficult to cope with them. This finding is confirmed by the policy bottom-up analysis. However, the demographic interviews revealed that environmental and institutional challenges are less important in the formation of a successor identity, while economic and social challenges are to a larger extent determining the succession decision.

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Social challenges are mainly the result of major trends such as intensification and scale enlargement. Farmers perceive low societal acceptance (5.11) as a major future challenge. Environmental challenges (GHG emissions, water quality, soil erosion) remain an topical topic in Flanders. Farmers will have to adopt far-reaching measures, that might interfere with productivity and production costs, and development of the farm. But this will depend on priorities in demand of society and legislation. Shifting consumer preferences might also be reflected in demands from buyers and supermarkets in their search for differentiation. Moreover, both growing and diversifying farms are struggling with labor pressure on their farms. Many farmers are dealing with a 'labor dilemma': they should decide to either rely on family labor and/or think of hiring external labor; or to invest in automation in order to be less dependent on expensive labor. It's not easy to find external labor to help farmers on a structural basis. Temporary work force is available through specific organizations but the quality of these workers is perceived as unpredictable. Similarly, all interview data reveal a perceived high administrative workload that is typically related to greening measures, agro-environmental climate measures, and legislation on manure and fertilizers. This contributes to the generally perceived high workload, as it was frequently indicated that farmers and farm households struggle finding a good work-life balance, and that the hard work is not adequately remunerated. Finally, the abovementioned challenges affect succession at individual farm level. High labor pressure, competition with other careers, negative image of the dairy sector, and low profitability all affect the intergenerational renewal at a family farm.

7.4.2 Farming system

In general, challenges at the level of the farming system are very often connected to challenges at the farm level. Suboptimal marketing strategies of the producer cooperatives might result in lower milk prices for the farmers. Low water quality, as a major environmental challenge in Flanders, results in frequently changing legislation. Thus, when farmers mention a particular challenge, such as strict manure legislation, they indirectly refer to a challenge at the level of the farming system or even at the regional level. Similarly, low availability of agricultural land, which is a challenge at the regional level, is reflected by farmers struggling with obtaining land. However, trade-offs at the different levels, do occur. The quota abolishment, which was perceived as an opportunity at the farm level, has been shown to be a major challenge at the farming system level. After removal of the quota, total milk production increased rapidly, with decreasing milk prices as a result. Economic growth in the region increases competition with other careers, with might interfere with finding a successor at the individual farm level.

7.4.3 Concluding remarks on challenges

Table 7.1 summarizes all challenges, dividing them by category (economic, environmental, social and institutional), by level (farm or farming system), and by duration (shock or long-term pressure). Most of these challenges are based on results from multiple methods.

Table 7.1. Summary of challenges across methods.

		Economic	*Environmental*	*Social*	*Institutional*
Farmers and farm households	Ranking of challenges based on the farm survey	1-2 (most relevant)	4 (least relevant)	3	1-2 (most relevant)
	Shocks	Low milk prices	Disease outbreak	Disease/accident of farmers and household members Succession	Frequently changing legislation (contradictory)
	Long term pressure	Low profitability High cost of production (both fixed and variable costs)		Labor pressure	Low (insecure) access to land Poor bargaining position of farmers Bureaucracy Keeping up with new technology
Farming systems	**Shocks**	Low milk prices (e.g due to Russian ban on dairy products)	Extreme drought events		Decoupling of CAP payments
	Long term pressure	Land availability Fluctuating milk prices	Water quality Climate change Energy consumption Soil erosion Manure surplus	Ageing of the countryside Competition with other careers Changing societal opinion	Bilateral trade agreements

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7.5 OPPORTUNITIES

7.5.1 Present opportunities for the farming system

During several workshops and interviews, **horizontal collaboration** between farmers has been mentioned as an opportunity. Small farms can work together to buy inputs in group, or to invest together in particular technologies as a cost saving strategy. As it is difficult for a single farm to attract external labor, as the farming family is unable to provide a full time contract, a cooperation between employers (multiple farmers) sharing one full time worker might offer opportunities. (Improved) horizontal collaboration among dairy farmers might increase bargaining power. However, not only collaboration between dairy farmers provides opportunities, but also dairy farmers together with arable farmers in order to improve crop rotation.

Additionally, dairy farmers must invest in **vertical cooperation** with other value chain actors. Stakeholders are convinced that the future of individual dairy farmers will depend on the way in which the dairy farmers fit in as an integrated part of the value chain. Cooperation within the value chain must lead to benefits for both dairy farmers and the dairy industry, by responding together to changing societal concerns. One branch organization has been established in Belgium (MilkBE), by the 3 Belgian agricultural organizations and the Belgian Confederation of the dairy industry (BCZ). Such branch organizations can focus on product quality, improving market transparency, etc.

One of the strengths of Flemish dairy farming is the high level of technical know-how. A wide spectrum of formation/education activities is available, a lot of initiatives to stimulate networking and knowledge exchange between farmers. However, during several workshops participants mentioned a lack of **managerial capacities** on many dairy farms. Farmers often have too little insight into economic numbers and how to use them. This is a challenge for future training to improve management skills.

Both interview and FoPIA-workshop data indicate that agro-tourism provides an important future opportunity to answer to societal demands and create added value on dairy farms at the same time. Additionally, the processing and sale of dairy products at home is easier for dairy products than for meat. Moreover, the dairy sector is perceived as more 'romantic' compared to e.g. poultry or pig productions, thus better suited for attracting citizens. It can be concluded that the **growing societal interest in local production and sustainability** offers future perspectives for the Flemish dairy sector.

7.5.2 Past opportunities for the farming system

The **abolishment of the dairy quota** in 2015 has been perceived as an opportunity for many dairy farmers to increase production. Total milk production has indeed increased since then.

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Technological development allowed for scale enlargement and improving production efficiency (per animal unit, per ha, per labor unit) as answers to the challenge of decreasing margins. Moreover, it has offered opportunities to deal with higher labor demand on these growing farms. By investing in automation technology, farmers mainly reduced labor pressure. Technological development thus improves on the one hand automation, thereby increasing labor and land productivity; on the other hand it additionally contributes to the more fine-tuned use of inputs such as feed, fertilizer, pesticides and medicines. Further, participants state that **family farming** is the most sustainable agricultural model in Flanders. It allows flexibility in labor input. Required labor input is dependent on seasonal variation and production cycles in livestock production. Therefore, participants do not think that family farms will be replaced by other models in the near future.

7.6 FUNCTIONS

7.6.1 Farmers and farm households

As presented in Figure 7.3, the farm survey analysis showed that in general the two most important farm business functions, perceived by farmers, are the achievement of a sufficient farm income (about 36%) and the delivery of high quality food products (about 27%). Ensuring animal welfare (about 14%) and maintaining natural resources in good conditions (about 11%) were two functions of secondary importance according to the respondents. It seems that Flemish dairy farmers, when defining farm purposes, are less concerned about protecting biodiversity, making the countryside an attractive place, providing proper employment, and producing biomass or biofuels. However, a relatively small share of observations (n=12) were not taken into account for this analysis, as respondents had the opportunity to add points to a self-reported other function. Among these, 'improving societal image on farming' appeared four times. This might be representing the statistic that only a small share of dairy farms in Flanders are providing education on their farm; and/or that not many farmers distinguish this function from ensuring the attractiveness of rural areas in terms of agro-tourism and residence. Similarly, the function 'providing employment and good working conditions for employees' was scored significantly low, a result that mirrors the dominance of family farms over corporate farm models in the Flemish dairy farm sector.

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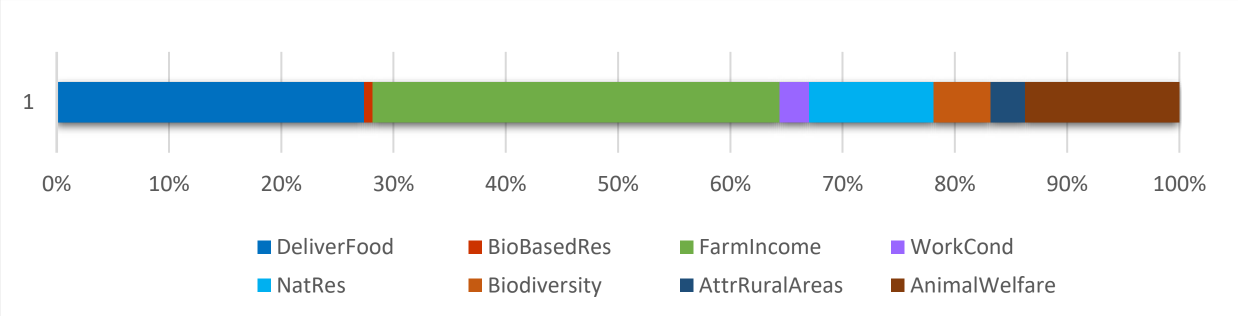

Figure 7.3. Relative Importance of essential functions (averages) according to the farm survey (n=208). Note: FarmIncome – ensure a sufficient farm income; DeliverFood – deliver high quality food products; NatRes – maintain natural resources (e.g. water, air, soil) *in good condition; AnimalWelfare – ensure animal welfare; WorkConditions – provide employment and good working conditions for employees; Biodiversity – protect biodiversity; AttrRuralAreas – ensure the attractiveness of rural areas in terms of agro-tourism and residence; BioBasedRes – deliver bio-based resources (e.g. hemp, wood) to produce biomass and biofuels.*

These results are validated by the learning, demographic, policy interviews, and the biographical narratives. Although a considerable amount of farmers acknowledged that a farm has more functions than only food production and providing income, the predominant role of these two functions is typically emphasized. Probably, the perceived low performance of the function 'gaining sufficient income out of farming', might explain that farmers emphasize the importance of this function during the interviews. Likewise, the commonly perceived low succession perspective and low bargaining position in the food chain might be associated with this low performance of the function. From the policy interviews, it seems that farmers find that legislation already provides many incentives and obligations to take up environmental friendly practices. Indeed, farmers believe that they already put sufficient effort in maintaining natural resources and protecting biodiversity. They occasionally argue that other sectors than agriculture should also contribute towards a climate neutral society, instead of agriculture always being looked upon as 'predominant polluting industry'. Moreover, data from all interview tasks confirm a perceived tension between nature organizations and farmers. Nature and agriculture are seen as rivals that are difficult to harmonize. This finding supports farmers considering 'protection of biodiversity', 'increase attractiveness of the countryside', and 'maintain natural resources' as less essential compared to gaining income and producing food. The relatively low importance of the function 'attractiveness of rural areas for residence and agro-tourism' might partially explain the perceived distance between farming and general society and might be reflected in the perceived lack of knowledge of general society about farming and food production. Another topic that consistently arose from the interviews, was that dairy farmers experience an implicit assumption from other farming system actors that they should intensify and/or upscale their farm in order to respond to low profitability and margins. This probably closely relates to the important role of the food provision function.

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From the demographic interviews, it appeared that some farmers (or other family members) have intense emotional relations with their dairy cows, indicating that the survey finding on the moderate importance of animal welfare might be hiding answers that significantly differ between farmers. Also, ensuring farm continuity seemed to be one of the key goals on family farms. More importantly, farming is often described as a lifestyle rather than an occupational choice; being an important part of the identity of the farmer/farming family. Farm household members often were in some sort of quest towards a harmonized balance between farm work and family life. From these findings, we can conclude another function of major importance for farmers, that is, maintaining work-life balance, or relating to the 'quality of life' function in the next section.

7.6.2 Farming system

Below, findings from the FoPIA-SURE-Farm workshop are discussed. It should be noted that the workshop results are largely determined by participant group configuration. A second note relates to the function definitions that differ from the question phrasing in the survey. For example, contrary to the questionnaire expression, the provision of bio-based resources was more generally interpreted during the workshop as also comprising meat and crop production. Another difference with the questionnaire was the conversion from 'providing employment and good working conditions to employees' towards defining the function 'quality of life' described by three indicators (average amount of working hours per day/farmer, pride of profession, number of fully employed workers per farm). As a result, the interpretation during the questionnaire analysis differs from the interpretation we hold while discussing FoPIA-SURE-Farm results.

Figure 7.4 shows that workshop participants score economic viability, food production and natural resources as most important functions. Economic viability is more important for farmers, while food production and maintaining natural resources are more important for industry and other stakeholders. Similar to what has been discussed in the previous section on interpreting survey results, the workshop participants also suggested a correlation between rural attractiveness and maintaining natural resources.

Regarding their performance, Figure 7.5 shows that all indicators score low to moderate. It is remarkable that the function 'provision of a viable income' is highly important, but poorly performing according to the participants. Quality of life also gets a low average score (2.51). Mainly farmers perceive too much hours of work per day as hampering quality of life. In general, the indicators from the functions that relate to the provision and maintenance of public goods (maintain natural resources, protect biodiversity, and improve attractiveness of the countryside) tend to score higher on performance compared to the indicators belonging to the functions that relate to the provision of private goods. Farmers and industry give higher scores for all indicators

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related to 'maintaining natural resources' and 'biodiversity' compared to the participants in the group 'others'.

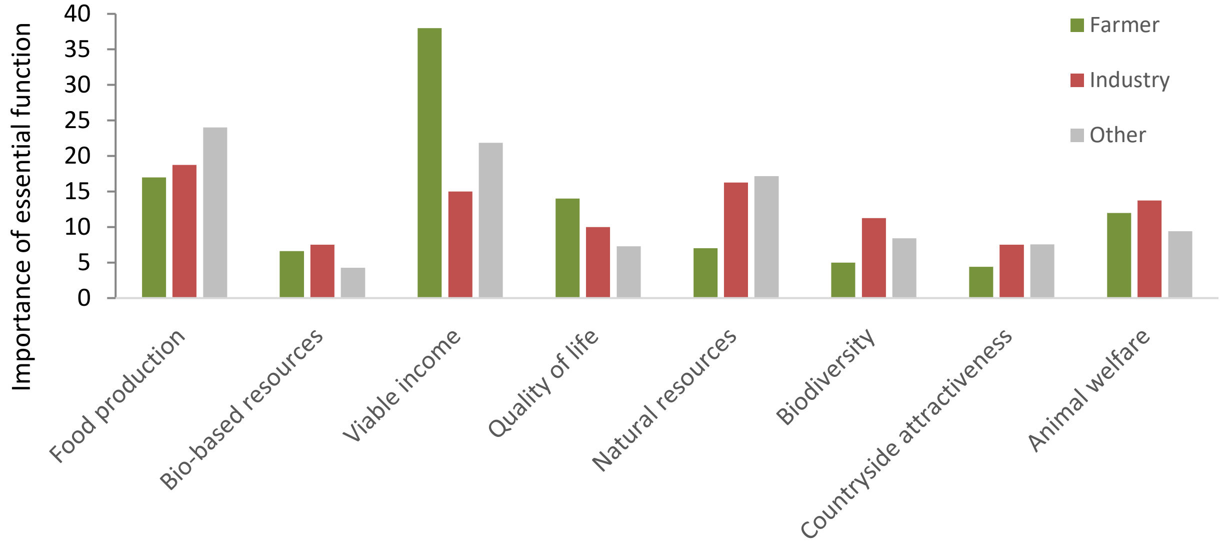

Figure 7.4. Average scores for importance of essential functions of the farming system, for different stakeholder groups (farmers, industry, and others). Respondents were asked to divide 100 points over eight predefined functions (n = 16).

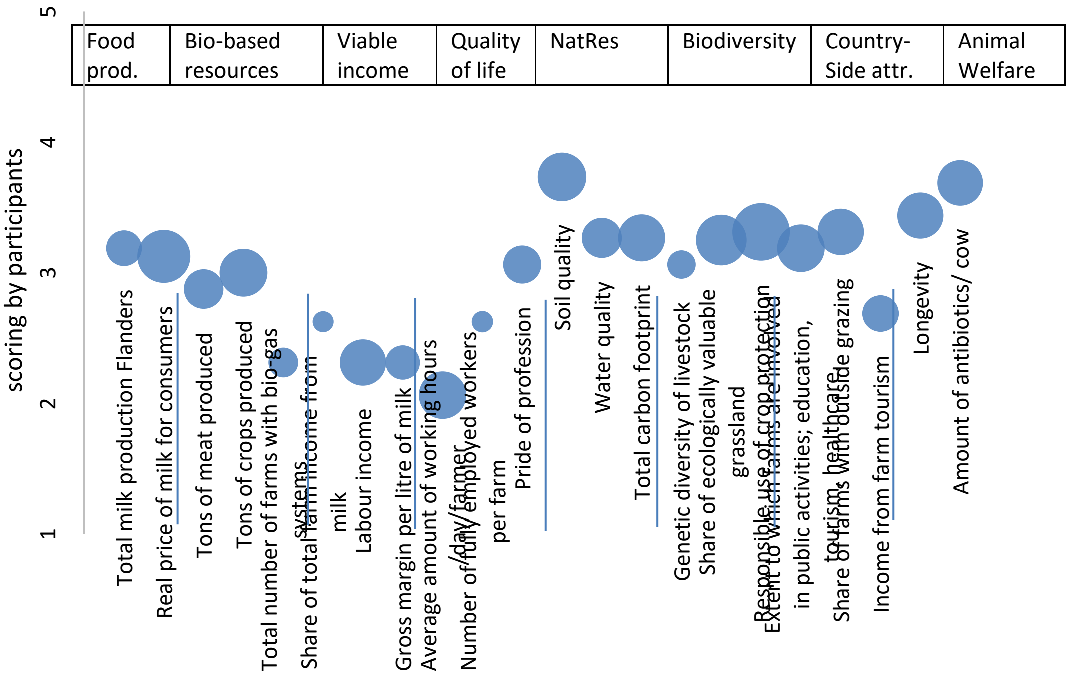

Figure 7.5. Bubble graph presenting averaged scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles) for assessing the corresponding function. Figure obtained from FoPIA-SURE-Farm workshop results (n = 16).

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7.7 RESILIENCE CAPACITIES AND STRATEGIES

7.7.1 Farmers and farm households

The survey results show that, at farm level, robustness scored highest on average (3.24), while average scores for adaptability (3.01) and transformability (2.71) are lower (see Figure 7.6). For all resilience capacities, however, there is a large dispersion between respondents, indicating that the farm specific situation is largely influencing the perceived resilience capacities of Flemish dairy farms. Figure 7.7 shows that the frequency distributions of adaptability and transformability are more right-skewed compared to the distribution of robustness, indicating that more farmers of the sample gave a low score (less than 3) for their farm's adaptability and transformability, whereas the assessment of their farm's robustness follows a more normal distribution (i.e. the number of farmers who score their farm's robustness to be high and those who score it low are more equal).

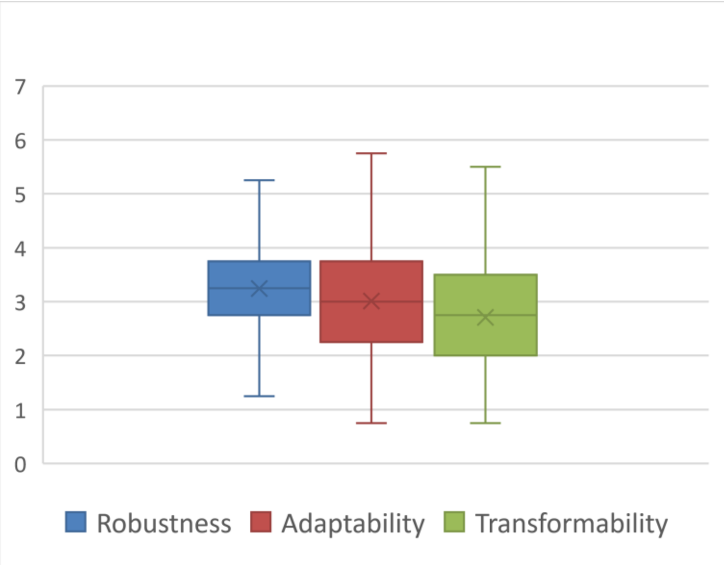

Figure 7.6. Boxplots representing scores for the three 3 resilience capacities based on the farm survey.

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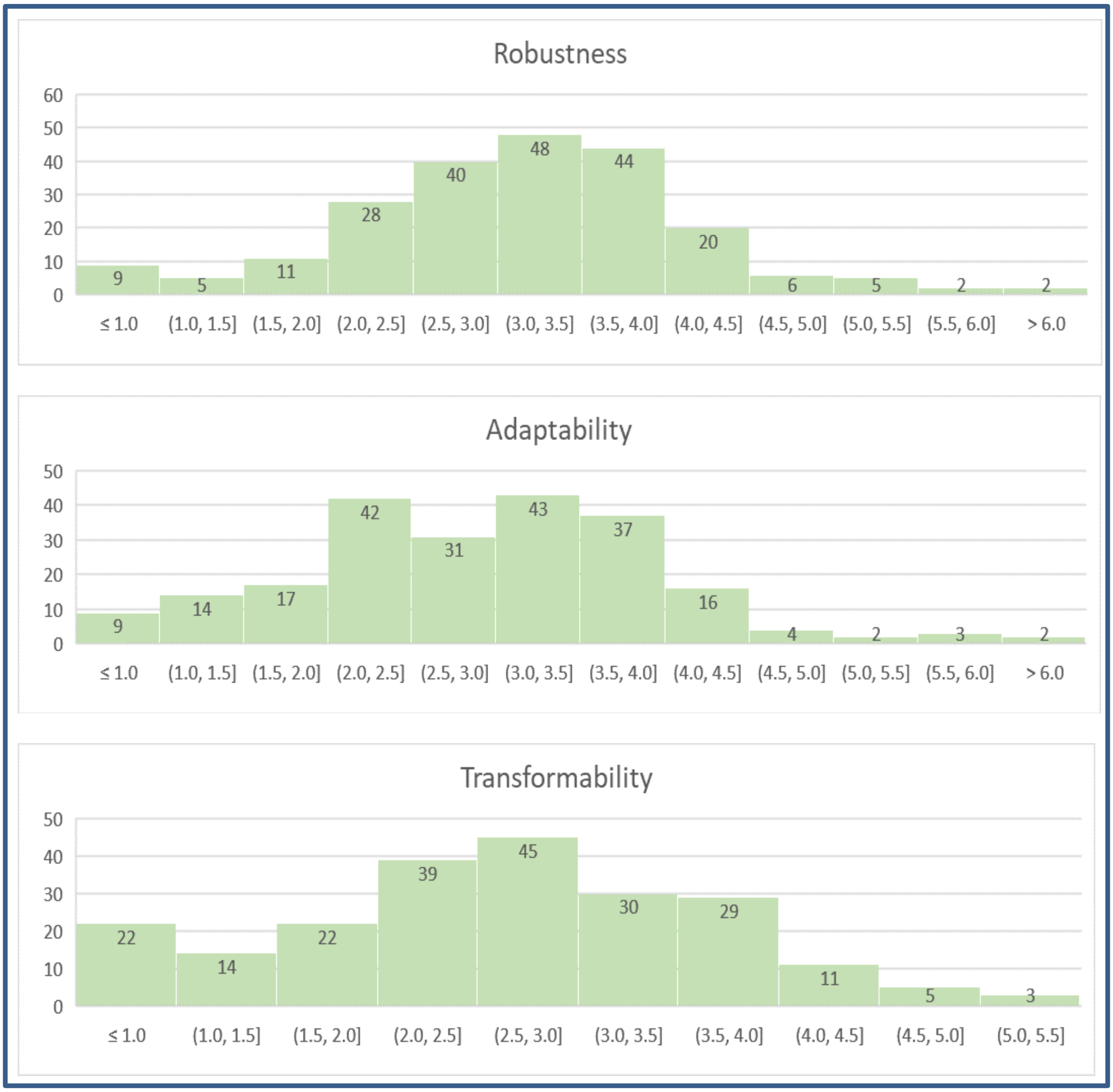

Figure 7.7: Frequency distribution of the three resilience capacities based on the farm survey

Results from the learning interviews may partially explain large differences between respondents in their perception on resilience capacities. Some farmers focus on strategies that increase farm robustness. For example, to cope with price volatility, these type of respondents try to build up a buffer when prices are higher in order to compensate for the times when prices are low. In contrast, other respondents consider farm transformation in order to respond to challenges. These farmers converted to organic production to get a more stable milk price, or they considered on-farm selling or diversification towards e.g. meat production.

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Contribution of policies to resilience of farmers and farm households

The contribution of policies to the resilience of farmers, their households, and the farming system at large was assessed with the Resilience Assessment Tool (Termeer et al., 2018). Firstly, a policy document analysis was conducted to analyse the priorities of Flemish and European policies affecting the dairy sector. This document analysis distinguishes policy goals and the implementation of policy instruments (cf. Figure 7.8). Secondly, a series of 20 interviews was conducted to elicit farmers' and other stakeholders' perspectives on the contribution of policies to resilience at farm and farming system level (Figure 7.9).

Figure 7.8. ResAT wheel depicting results of the policy document analysis. Four indicators for enhancing policies are scored for each resilience capacity. Scoring is done on a five-point scale, with dark red representing the most negative score, yellow a neutral score, and dark green the most positive score. White fields could not be scored.

Policies contribute to the robustness of Flemish dairy farms by applying a rather short-term focus, by strongly protecting the status quo in the sector, and by promoting risk management (cf. Figure 7.8 left side). The short-term focus is reflected by the preservation of the dairy market safety net[1] at EU level, and the slow convergence in direct payment entitlements in Flanders. This slow convergence also reflects a protection of the status quo, i.e. a limitation of structural change. Dairy farms are among the highest beneficiaries of direct payments in Flanders. When considering direct payments as a buffer resource, dairy farmers are thus well-endowed with financial buffer resources. Although the Flemish Government emphasizes the need to improve of risk

[1] The dairy market safety net consists of various mechanisms for intervention by the European Commission in the dairy market, in case of exceptionally low milk prices. These mechanisms comprise purchases of milk powder and butter, and payments for voluntary milk production reduction.

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management in its communications, dairy farmers are offered little tools to do so. However, the existence of the dairy market safety net at European level limits the need for the Flemish Government to intervene in market risk management.

Policies contribute to the adaptability of Flemish dairy farms by enabling a middle-long term focus and flexibility at the farm level, and by stimulating varied and tailor-made responses of farmers. They appear to fail in contributing to farmers' adaptability by stimulating social learning. Of special importance for dairy farmers' adaptability is the Flemish support for investments in material assets, at 15% or 30% of the investment cost. 54% of the Flemish Rural Development (Pillar 2) budget is allocated to this support instrument. This support contributes to farmers' middle-long term focus, flexibility, and varied responses. It's impact on flexibility is not unequivocally positive, however: by stimulating unnecessary investments and debt, it may lock farms into certain development trajectories. Regarding social learning, the development of EIP-Agri and the founding of many EIP Operational Groups may certainly contribute in a positive way. Unfortunately, it appears that the Flemish Government could do more to propagate the efforts at EU level. Generally positive for the adaptability-enhancing character of policies is the Flemish Government's choice to shift 10% of the CAP Pillar 1 budget to Pillar 2: Pillar 2 consists of voluntary, varied measures while Pillar 1 provides involuntary, one-size-fits-all instruments.

Transformability of dairy farms is enhanced by the long-term focus of policies and by support instruments for niche innovations. The long-term focus of policies is reflected by the attention for generational change, and the entry of young farmers in the farming sector (both at Flemish and EU level). Entry of young farmers taking over an existing firm is served well by the relatively large lump sum payments they can apply for (€40,000-€70,000, depending on the size of firm taken over). The new policy instrument that supports innovative projects also reflects both a long-term focus and attention for niche innovations. Moreover, dedicated policy instruments exist to support organic and small farms, which are still exceptional, niche farming types in Flanders. Unfortunately, policies fail to enhance farms' transformability by stimulating in-depth learning. Although a set of policy instruments exist to support learning (both during schooling and as lifelong learning), critical (self-)reflection on general strategic choices is not encountered in these instruments.

The bottom-up analysis (Figure 7.9) based on interviews with farmers and other stakeholders revealed that the abolishment of the dairy quota system is perceived as the most impactful recent policy intervention affecting the Flemish dairy sector. Its impact on the resilience of dairy farms is contested: some respondents argue that it has pushed farmers towards upscaling and intensification, by allowing more fierce competition. Others believe the removal of quota has increased dairy farmers' entrepreneurial freedom, and thereby adaptability. The main current

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policy intervention instruments discussed were direct payments and the investment for support in material assets. The latter is believed to crowd out cooperative investment by supporting individual investment. This CAP Pillar 2 instrument is thus in conflict with other Pillar 2 instruments, that aim to improve cooperation among farmers.

The analysis revealed that the incremental adaptation of policies is perceived to harm the robustness of farms. For example, frequently changing restrictions on application of manure are perceived as a threat. Another interesting observation is that voluntary Pillar 2 measures are less well known among farmers. In addition, some perceive the application procedures for Pillar 2 funding demanding and complicated. Knowing that these voluntary measures are characterized as positive for farmers' adaptability, improving access to Pillar 2 instruments (possibly by increasing flexibility of the instruments) appears to be one way to contribute to farmers' adaptability.

With respect to transformability, restrictions imposed by Flemish spatial planning policy were contested. Some stakeholders believe this policy severely limits the diversification options of dairy farmers, especially regarding catering activities. Some respondents claimed that relaxation of the requirements on farming income in the spatial planning policy would lead to stronger diversification towards catering. Lastly, stakeholders participating in the validation workshop on September 17th, 2019, did not support the view that the level of payments for firm take-over are indeed sufficient to draw young farmers into the sector. They argued that some tens of thousands of euros are not enough to actually lower the financial risk of taking over a farm.

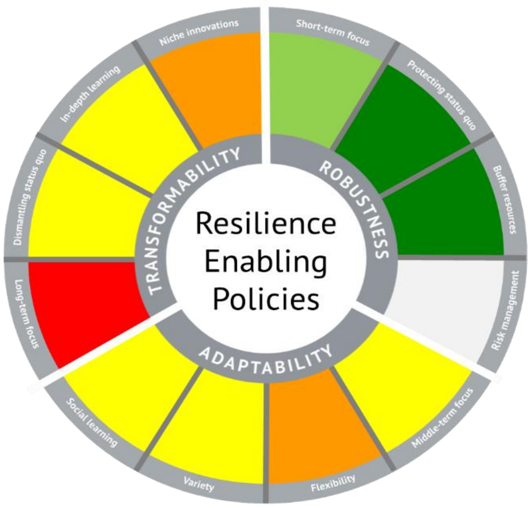

Figure 7.9. ResAT wheel depicting results of the bottom-up analysis of interviews on policy impacts. Four indicators for enhancing policies are scored for each resilience capacity. Scoring is done on a five-point scale, with dark red representing the most negative score, yellow a neutral score, and dark green the most positive score. Grey fields could not be scored.

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7.7.2 Farming system

Contribution of strategies to resilience capacities

According to the stakeholders in FoPIA-SURE-Farm, strategies affecting total milk production mainly contribute to robustness of the farming system (Figure 7.10). During the last decades, the number of dairy farms has decreased. By increase of efficiency and scale enlargement of the remaining farms, total milk production did not follow the decrease of dairy farms. After abolishment of the quota, total milk production increased. Also at the farm level, scale enlargement and intensification are perceived as mainly contributing to robustness. Investments are often repaid to the bank during 20 years, which might have a negative impact on flexibility and transformability.

Several strategies contributed to producing dairy products that are affordable for consumers. First, technological development served as a strategy to largely meet the demands for dairy products. Second, interventions (milk powder stocks) to deal with overproduction. Third, liberalization of the European market for dairy production was aimed to make the dairy sector more market proof. According to the participants, all these strategies contribute to robustness to maintain and even increase milk production in Flanders. Maintaining the diversity of dairy farms in Flanders, from very specialized to mixed farms, contribute to all three resilience capacities of the farming system according to the respondents. Also, strategies to reduce carbon footprint mainly contribute to robustness, although more efficient feeding, producing green energy and circular agriculture are perceived to contribute to the adaptive capacity of the farming system.

Figure 7.10 shows that, according to the stakeholders, strategies applied in the past generally contributed more to robustness than to adaptability and transformability. Only one strategy had a stronger contribution to adaptability than robustness (broaden business). For many strategies, there is even a negative contribution to transformability. Strategies implemented to improve total milk production and milk price, contributed relatively less to transformability, compared to strategies to improve labor income and carbon footprint. However, for all indicators, several strategies were applied that contribute to adaptability (e.g. increase efficiency, investments of cooperatives, circular agriculture).

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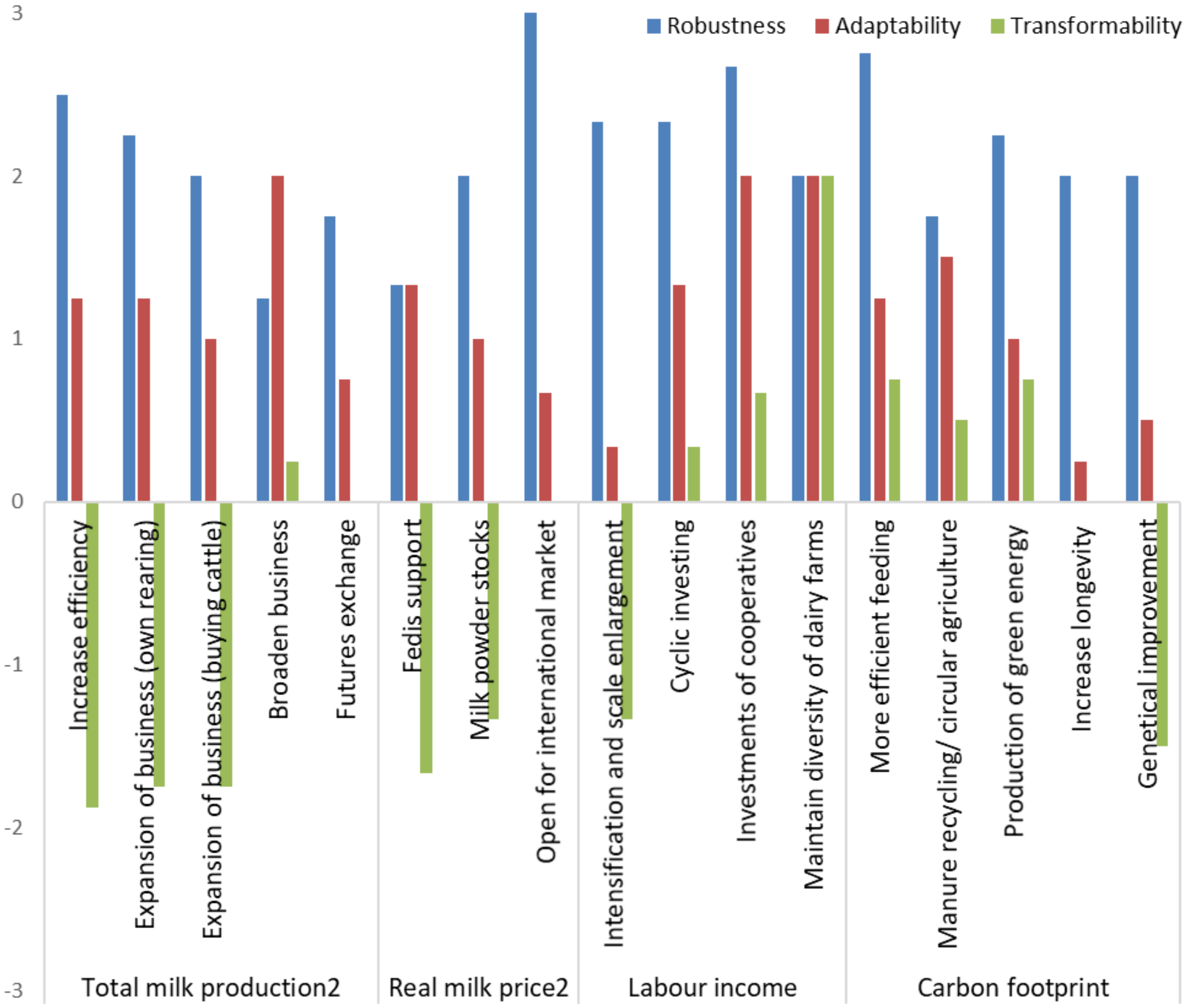

Figure 7.10. Strategies applied to cope with challenges affecting the indicators 'total milk production', 'real milk price', 'labor income', 'carbon footprint'; and their perceived contribution to the three resilience capacities according to stakeholders participating in the FoPIA-SURE-Farm workshop (n=15) (Source: Coopmans et al. (2019a).

Contribution of attributes to resilience capacities

According to the stakeholders, most resilience attributes contribute predominantly to robustness, then to adaptability, and then to transformability (Figure 7.11). For robustness, the farming system currently depends mainly on local and natural capital, and spatial and temporal heterogeneity. For adaptability and transformability, the farming system depends mostly on infrastructure for innovation and spatial and temporal heterogeneity. Exposure to disturbances stimulates the farming system to adapt.

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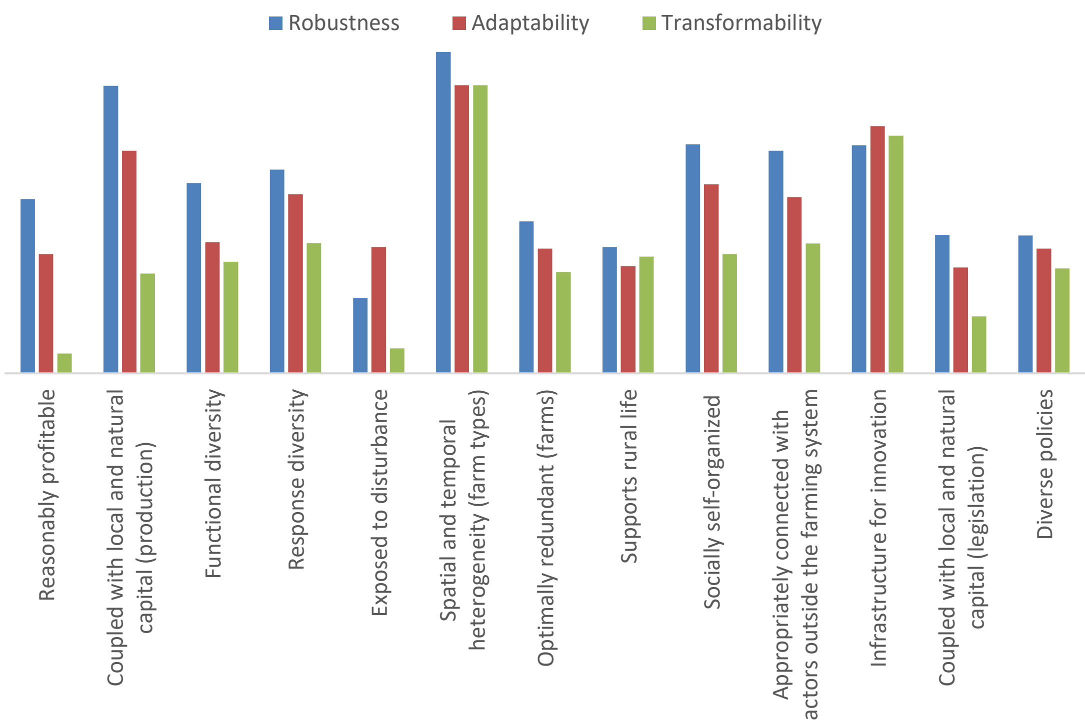

Figure 7.11. Current performance of the attributes combined with the contribution of the 13 resilience attributes towards resilience capacities, according to the stakeholders in FoPIA-SURE-Farm workshop (n=15) (Source: Coopmans et al., 2019a).

Contribution of policies to resilience of the farming system

The contribution of policies to the robustness of the Flemish dairy farming system is expected to work in an often antagonistic way, as compared to their contribution to the robustness of individual farms (Figure 7.8; note that the scoring of ResAT indicators does not distinguish policy impacts at farm and farming system level). Intervention by dairy market safety net measures benefits all farmers in times of crisis, but is likely to postpone structural transformation that could lead to a better adjustment of milk supply to demand. Similarly, the high amount of direct payments, and slow internal convergence thereof, is expected to keep less robust farmers in business, limiting the growth of more robust farmers by for example complicating access to land. On the other hand, direct payments do provide a buffer to the dairy farming sector as a whole.

The contribution of policies to adaptability of the Flemish dairy farming system takes place in similar ways as described previously for farms and households (Section 7.7.1). Support for investment in material assets is expected to increase flexibility and middle-long term focus at sector level. However, it can be argued that such a policy directs the farming sector to develop in a specific way: the way of continuous investment in technological innovation, requiring high output and thus often high input. It is thus unclear whether the policy instrument is beneficial to

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variety and tailor-made responses at farming system level. Also direct payments are a one-size-fits-all policy instrument that may lower the diversity in strategies of farmers, by reducing the need to adapt. With a lower amount of strategies being practiced, the adaptability at system level is compromised.

Policies contribute only little to transformability. This could be done by applying a long-term focus, dismantling incentives that support the status quo, and stimulating in-depth learning and niche-innovations. Direct payments and the dairy market safety net both stand in the way of dismantling incentives that support the status quo. The Flemish choice to slowly converge direct payment entitlements between Flemish farms reflects that dismantling these incentives is not a priority. With respect to the dairy market safety net, this consideration may be more theoretical than of high practical importance. As intervention purchases are only initiated when the market price drops below 40% of the long-term average milk price, some stakeholders argue this instrument hardly affects farmers' strategies.

As discussed in the previous section on the resilience capacities of farmers and farm households, the abolishment of the dairy quota system is perceived as the most impactful recent policy intervention affecting the Flemish dairy sector, and its impact on the dairy sector's resilience is contested. The general tendency is a strong increase in milk production since the abolishment, and intensified upscaling. Therefore, some respondents believe the abolishment to have contributed to the sector's robustness, but reduced the sector's adaptability, as the sector is moving towards upscaling even faster than before. Other policy impacts on the resilience capacities of the dairy farming system are similar as in the case of farmers and farm households. The indicated large importance of direct payments is notable: this reflects a general tendency of low contribution to adaptability and transformability.

Contribution of actors to resilience capacities

Actors in and beyond the farming system mainly contribute to robustness and to a lesser extent to adaptability. Research organizations contribute more to adaptability than to robustness. Several actors constrain transformation of the farming system, such as distribution, processing industry and input suppliers. This is not really surprising as they have a big interest in retaining milk production as it supports their business model. It should be noted that the participants had difficulties in scoring the contribution of the actors to the different capacities of resilience.

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7.8 RESILIENCE ATTRIBUTES

7.8.1 Farmers and farm households

As illustrated by Figure 7.12, it appears that most Flemish dairy farmers do not feel very supported by their network based on survey data. It is remarkable that approximately half of the survey respondents reported that farmers are not keen to help each other when problems occur, although knowing farmers from the neighborhood was commonly scored rather high. However, the learning capacity interviews showed that involvement in social networks and knowledge exchange, both between farmers and between farmers and other stakeholders, can provide important opportunities by supporting individual experimentation, farm adaptations, the adoption of new technologies, and the spread of knowledge about coping strategies for challenges that farmers are faced with. Further, proactive learners (mostly farmers who are keen to learn more about alternative farming strategies, who are actively networking and attending various meetings, and farmers who are open to experimentation) seem to be more successful in implementing improved farming techniques or models compared to reactive learners (farmers who are not actively anticipating potential upcoming challenges). Also, being open to new ideas is indeed a precondition for adaptability and transformability (not being open-minded is thus constraining a farm's general resilience), while from the survey we learnt that most farmers are not keen to try out all kinds of new technologies and breeds (Figure 7.13); which could be interpreted as a proxy for an individual’s openness to new ideas. Furthermore, unanticipated events may turn out either damaging or beneficial for farmer or farm household resilience. For example, families confronted with sudden events of death or health issues can end up in a locked in situation and not have the courage to call for external help. Examples of beneficial consequences of unanticipated events are farmers attending events during which they meet key informants to learn about new farming technologies or alternative farming perspectives that initiate an on-farm change process that improves (perceived) farm resilience. Likewise, the embeddedness of a farm in the local community can either hinder or support farm adaptations. These findings suggest that there is still room for further increase of the system’s *openness* and *modularity*, which would benefit its capacity to capture opportunities and to become more adaptable.

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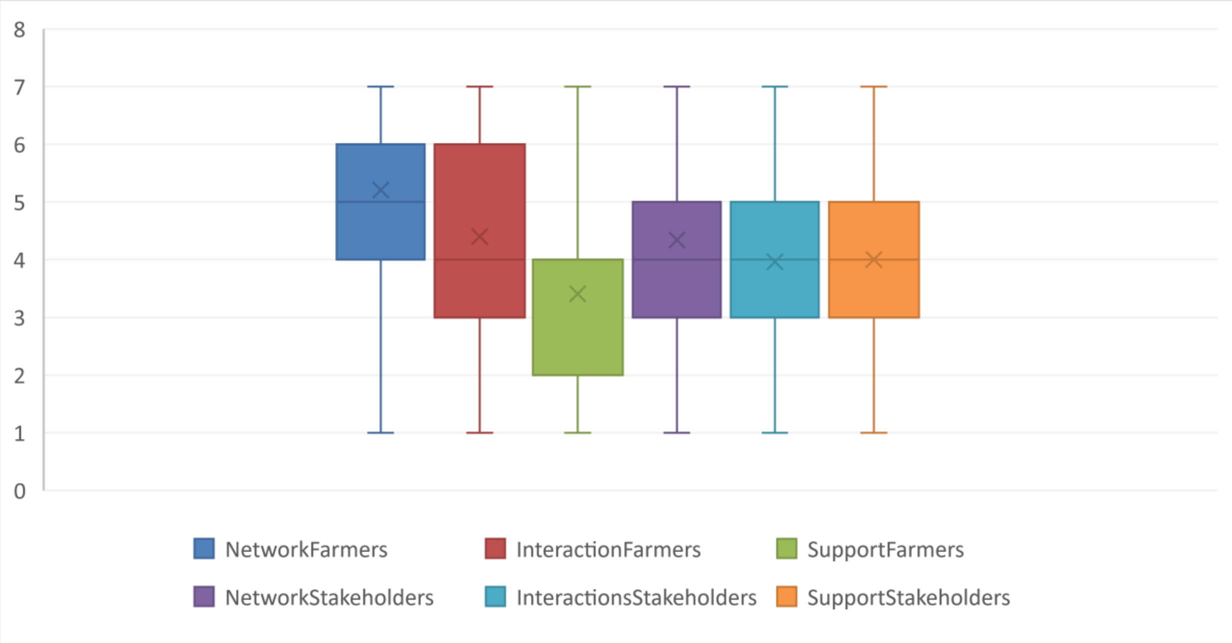

Figure 7.12. Boxplots showing the distribution of farmers' answers (7 point Likert scale) on the SURE-Farm survey questions relating to network. Note: NetworkFarmers - I know a lot of other farmers in my region; InteractionFarmers - Concerning farming, I often interact with neighboring farmers; SupportFarmers - Farmers in my region tend to support each other when there is a problem; NetworkStakeholders - I know a lot of agricultural professionals, experts, or value chain actors; InteractionStakeholders - When I attend agricultural events and meetings, I interact a lot with professionals, experts, or value chain actors; SupportStakeholders - I feel I can receive support from agricultural professionals, experts, or value chain actors in my network.

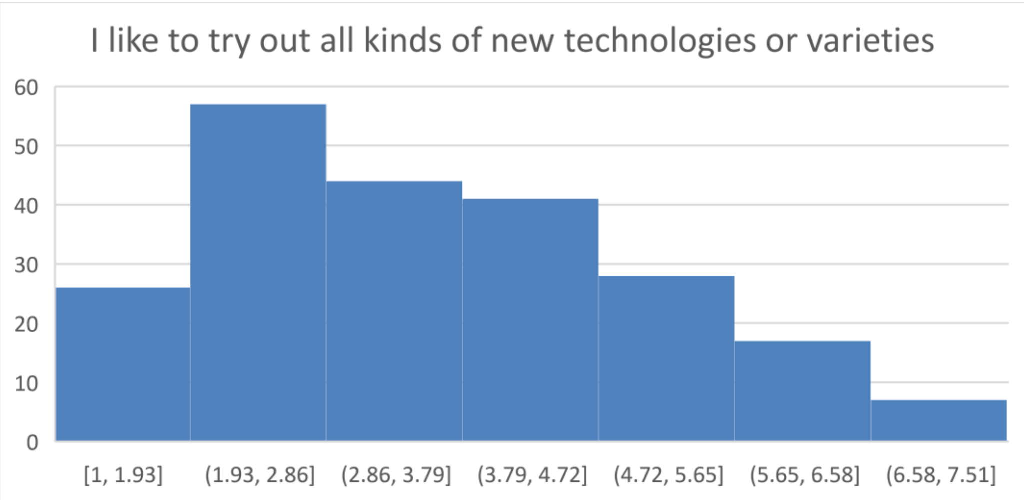

Figure 7.13. Frequency distribution of of farmers' answers (7 point Likert scale) on the SURE-Farm survey question relating to experimentation and innovation (n=220).

Interview data (all in-depth interviewing methods) provide evidence that support from family members can profoundly contribute to farm (household) resilience, especially by contributing to

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the generic resilience principles *flexibility*, *modularity*, and *system reserves*. First, family members usually provide cheap and flexible labor. Second, and related to this, the family farming model is perceived as a sustainable and resilient model regarding financial and land use opportunities, as dairy farming is a highly capital-intensive occupation. Third, the presence of supportive family members is an enabling factor when a farmer is considering change, thus also interfering with system *openness*. Fourth, despite having a successor identified or not, different family members are typically devoted to family farm continuation. In case of a shock, they often react in a way that maintains the status quo (inertia), thereby mainly supporting farm (household) robustness.

From interview data, we also find that constraining attributes mainly relate to farmers' personality characteristics. Some farmers are not willing to adapt, experiment, or implement new risk management strategies or farming activities. Additionally, most farmers view the policy framework as rather disturbing or limiting their on-farm resilience. This finding mostly refers to complex administrative work by farmers for complying with various legislations, and to audits on farmers to check whether they work conform certain legislator obligations. Especially the perceived inflexibility of certain specific policies, by looking at farm(er)s checklist-wise instead of entity-wise while assessing a farm's qualification for applying for support schemes, disincentivizes farmers to adapt. The creation of policy measures that aim at increasing attractiveness of the farming occupation and lifestyle is probably crucial for effectively enabling future generational renewal.

7.8.2 Farming system

Figure 7.14 shows that the 13 specific resilience attributes, defined within FoPIA-SURE-Farm, were scored low to moderate regarding their current performance.

First, *openness* of the system is considered to be moderate, looking at the attributes 'Exposed to disturbance' and 'Infrastructure for innovation'. This means that the system scored a preferably score on this general resilience attribute, since it is argued in literature that both very low and very high degree of openness negatively contributes towards resilience (Resilience Alliance, 2010). Frequently exposing a farming system to small perturbations without causing it to move to another state, enhances natural selection and helps it to re-organize internal structures (Cabell and Oelofse, 2012). Since the abolishment of the milk quota, the fluctuation of milk and feed prices has continuously affected the farming system. According to Cabell and Oelofse (2012) this continuous exposure can result in a positive influence towards the system's adaptability because only the stronger actors of the system can survive frequent shocks, and it creates an incentive to adopt new strategies. The current performance of the infrastructure for innovation was scored slightly higher. This indicates that the participants were of opinion that the existing infrastructure enables the farming system to adopt new technologies and new ways of production to cope with

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a changing environment (Meuwissen et al., 2019). However, new farmers entering the system is seen as a major future challenge.

Second, the lowest attribute performance belongs to 'Reasonably profitable', illustrating that farmers do not earn a sufficient income and the farming system likely relies on subsidies. The low profitability is pressurizing the *system reserves*. Contrary to 'reasonably profitable', the two other attributes contributing to system reserves 'coupled with local and natural capital (production & legislation)' and 'supports rural life' scored moderate. The moderate score for 'coupled with local and natural capital (production)' is somewhat contrasting to what would be expected of an intensifying system. In literature it is argued that intensification often results in a negative resource balance (Tscharntke et al., 2005). The challenges (Table 7.1) show that there are several problems that arose from an unbalanced extraction of resources. Especially long-term pressures such as soil degradation, poor water quality and an increasing pest and disease pressure can result from a poor complement with natural capital in a farming system (Tscharntke et al., 2005). Additionally, although several analyses (FoPIA-SURE-Farm, policy top-down and bottom-up analysis) suggested that many regulations are aimed at reducing the negative impacts of the agricultural system on the natural environment, the FoPIA-SURE-Farm participants scored the coupling with local and natural capital in a legislative sense slightly lower. This attribute describes whether the norms, legislation and regulations are adapted enough to the local conditions (Meuwissen et al., 2019). Thus, for both these attributes (production & legislation) there is room for improvement. Further, regarding the attribute 'supports rural life', the rural life is moderately supported by the farming system according to the FoPIA-SURE-Farm participants. This means that the participants think there is a moderately balanced population in sense of age and that there is a moderate availability of facilities (Meuwissen et al., 2018). However, interview respondents and workshop participants seemed to be worried about the low succession rate within the farming system. It can be concluded that the general resilience of the system regarding the *system reserves* is rather low.

Third, *diversity* in the farming system was scored low. Stakeholders especially think that the farming system is lacking 'functional diversity' and 'diverse policies'. This indicates that the array of eco-system services is small and unvaried and that the current policies do not support strengthening of all resilience capacities. First, a lack of 'functional diversity' leads to vulnerability to both shocks and long-term pressures and an unsustainable extraction of natural resources. Challenges the system was sensible to because of a lack of functional diversity are for example the Russian embargo on dairy imports, over-production and sensitivity to drought. Second, the low scoring of the attribute 'diverse policies' relates to the challenge of frequently changing regulations that has been discussed in section 7.4 (Table 7.1). During the workshop it became clear that there is a lack of a stable and safe environment that enables adaptations and/or

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transformations of the farming system. Although the level of implementation of response diversity was higher (Figure 7.14), the strategies corresponding to the challenges that were found during the workshop were strongly focusing on robustness (Figure 7.8). It has been argued in literature that this is a pitfall for general resilience (Folke et al., 2010). A system that is efficiently adapted to frequent perturbations is likely to be more vulnerable to unexpected challenges.

Fourth, *tightness of feedbacks* of the system are considered moderate to high. 'Self-organization' was largely discussed during the workshop, as agricultural organizations play an important role in the farming system. Many stakeholders within the farming system internally organized themselves to improve bargaining power. However, farmers stated that their influence on the strategies of these large cooperatives has decreased in the last 20 years. Although the connectedness with outside actors was assessed relatively high, there is room for improvement regarding embeddedness of the system in society and connection with consumers.

Fifth, *modularity* scores ('spatial and temporal heterogeneity' and 'optimal redundancy') are ambiguous. A relative high score for 'spatial and temporal heterogeneity' indicates that participants think that there is a wide diversity in farm types regarding their economic size, degree of intensification and of specialization. However, stakeholders are convinced that the general direction of the system will stay towards more intensification and scale enlargement. This perception was confirmed during the interviews. Another characteristic of a modular system is that, when a challenge is encountered, sub-systems can quickly reorganize to avoid a collapse. The optimal redundancy of the system was scored low (Figure 7.14). Farming systems that show redundancy allow for farmers to exit the system without this posing a threat to its continuation and the easy entering of new farmers into the system. For the dairy farming system in Flanders, the exiting of farmers does not seem to be a big threat. However, the participants often mentioned the difficulty for new farmers entering the system during the workshop. The high capital intensity and the low availability of land are the main causes of this problem (Table 1). Although there is no optimal level of modularity (Resilience Alliance, 2010), it can be concluded from the workshop that the lack of land and the high capital intensity are threatening the redundancy of the system. However, the historical dynamics of the system's indicators show that the system is able to absorb shocks. Another characteristic of a modular system is that, when a challenge is encountered, sub-systems can quickly reorganize to avoid a collapse. However, during the workshop a stakeholder mentioned that it is very difficult for a system that mainly produces one product to be flexible. Moreover, it is even harder for the typical family owned farming businesses that are very capital intensive. He argues further that, after making a large investment, the farmer has to continue in that direction for a long time in order to earn back that investment. The modularity of the system is thus on one side backed by the high capacity of the system to

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absorb shock and on the other side being pulled by the low flexibility of the system. The flexibility of the system was mostly explored using the ResAT wheel method, as discussed in section 7.7.

7.8.3 Concluding remarks on resilience attributes

When combining the results for the current performance of the attributes and their contribution towards the resilience capacities (Figure A12), it can be concluded that the most important attributes for the system are the spatial and temporal heterogeneity and the infrastructure for innovation. Other important attributes are appropriate connectedness, social self-organization and response diversity. These are, based on the workshop outputs, the attributes with the highest potential to contribute towards all resilience capacities. For robustness, coupling with local and natural capital and functional diversity are also important. The lowest contributors towards the system resilience are exposing to disturbances, supporting rural life and diverse policies. The biggest opportunity for improving the resilience of the farming system might lay in these attributes.

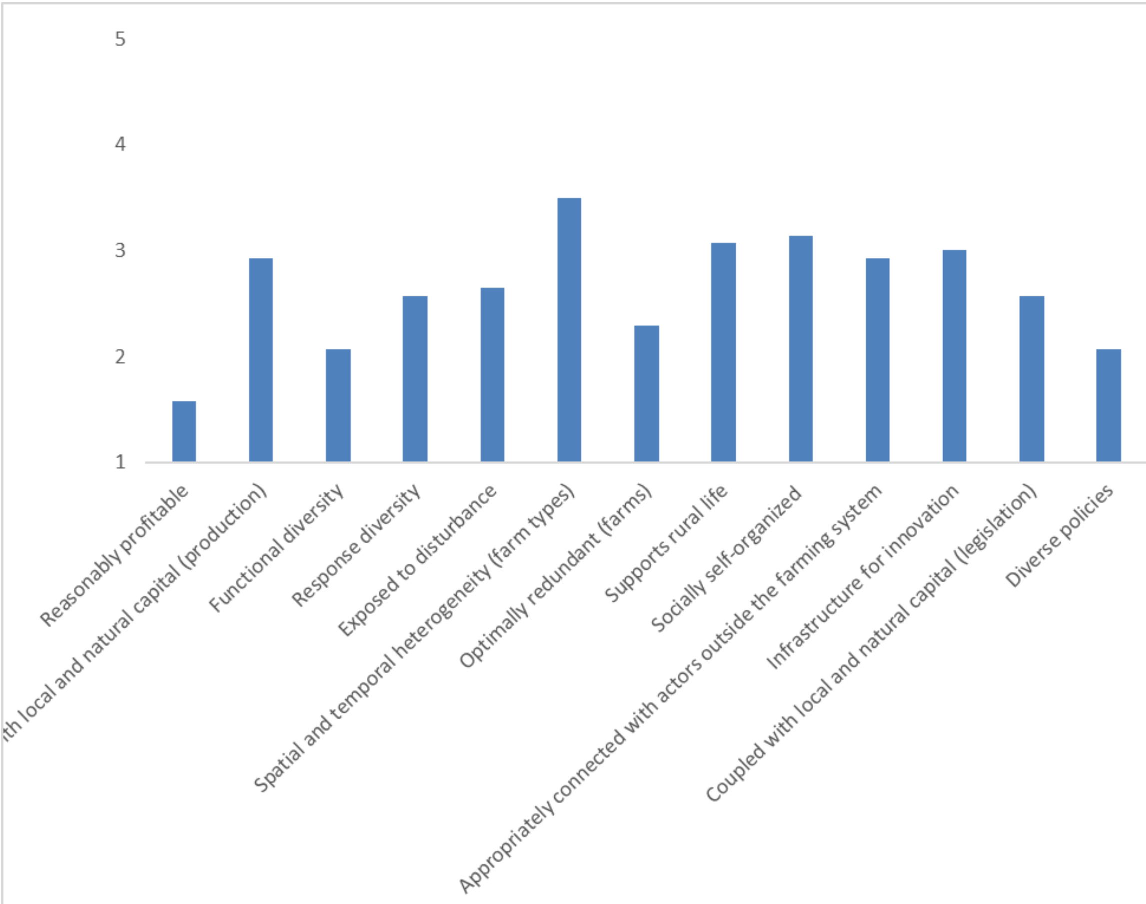

Figure 7.14. Performance of attributes on a scale from 1 (not at all) to 5 (very big extent), n=15 (Source: Coopmans et al., 2019a).

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7.9 ADAPTIVE CYCLE

Agricultural production, when focusing on the function of food production, is *in between the growth and conservation phase*. The dairy farming system has been in a conservation phase as long as quota determined milk production in Flanders. Since the last decade, after liberalization of the market and abolishment of the dairy quota, total milk production has been increasing. As the number of dairy farms decreased, this increased milk production at the farming system level results from an increased milk production at the farm level. The increased milk production has required reorganization both at farm level and at farming system level, which is still ongoing. To increase milk production at the farm level, farmers either improved productivity (milk production per cow) and/or enlarged their dairy herd. At the same time, the largest cooperative in Flanders made investments to absorb the increased milk production of its members. However, as almost all farms in Flanders depend mainly on family labor, several farmers and farming families are running up against their limits in terms of labor, and mental and physical health. Labor pressure and finding a good balance between labor and family life are challenges mentioned during many of the interviews and workshops. Farmers do invest in equipment to enable labor efficiency, among which automation equipment for milking and feeding the animals. These large investments require farmers to repay their debts for many years, which hampers flexibility. These farms can be considered in the conservation phase. The presence of a successor or not, has a major impact on the subsequent phase in the adaptive cycle at farm level. Often, when a new generation enters the farming business, a phase of farm development (reorganization and/or growth) occurs. When a farmer has no successor, the remaining buildings and land might remain part of the dairy farming system, depending on to whom the farm is sold. At the farming system level, the number of farms is still decreasing, while the average age of the farmers is increasing and skills to run a dairy farm are evolving from more tacit knowledge towards the need of more managerial competencies. Based on this reasoning, we suspect the *farm demographic process* is in the *reorganization phase* of the adaptive cycle.

Further, we consider both *risk management and governance processes* as mostly *in between conservation and collapse phase*. The most important function, economic viability, has a low performance. Price volatility is high, and when milk prices have been low, many farmers have been struggling. Several strategies have been discussed during the interviews and workshops to deal with this price volatility, among which hedging, maintain a financial buffer, rethinking investments, diversification. However, the implementation of these strategies has been perceived as suboptimal. Besides this, the most important perceived environmental challenge by the farmers is climate change. Several periods of severe drought have had a negative impact on the cost of production. Strategies to adapt or to manage these risks, should be developed to prevent collapse at the farm level. Policies have the capacity to support all three resilience capacities, but

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in practice the policy measures turn out not to be effective in improving adaptability and transformability of farms. Especially the administrative load that comes with the complexity of incoherent policy implementation is perceived as obstructing farmers' resilience.

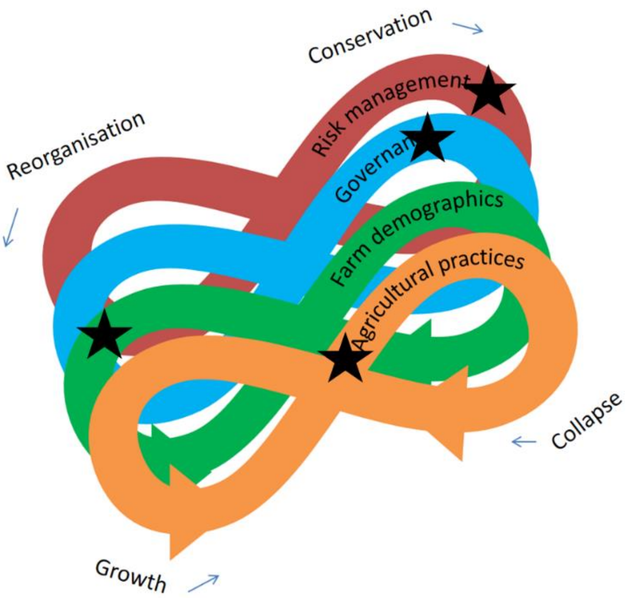

Figure 7.15. Positioning the Flemish farming system on the adaptive cycle of processes in agriculture

7.10 FUTURE STRATEGIES

Table 7.2 summarizes future strategies mentioned per process. These strategies were mainly addressed during the FoPIA-SURE-Farm workshop, AgripoliS workshop and the Risk Management workshop. Although some of the strategies have already been applied in the past, they do seem relevant for the future as well.

The first one of these strategies is **technological optimization.** Accompanied by the strategy of scale enlargement, many farmers also invest in technologies to improve production efficiency (per animal unit, per ha, per unit of land) and to reduce labor pressure on these growing farms. However, managerial capacities to decide what investment should be made are becoming more important. Therefore, many farmers should put more effort in gaining more insight in farm economics.

Other future strategies address price volatility. As a consequence of liberalization of the markets, price volatility is expected to continue in the future. Although several strategies are implemented, they still can be improved. For instance, one of the strategies to deal with price volatility is by having a **financial buffer**, meaning that farmers maintain some financial savings to use these in hard times, when necessary. However, there is a need for strategies to inform farmers about the

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importance to maintain a financial buffer and to stimulate/facilitate the creation and maintenance of a financial buffer. More, strategies to improve **cooperation within the value chain** are needed to deal with price volatility in international markets. Some evolutions concerning the use of contracts in the Flemish dairy farming system are observed. Some retailers are taking initiatives to set up long-term contracts with individual farmers. This is a positive evolution as farmers are more secure on sales and milk price. However, farmers might need to adjust their infrastructure or production process, based on the demands from retail. They might depend too much on one distribution channel. It is up to the farmers to organize themselves to increase their bargaining power and not to be completely dependent on demands from retail and processing industry.

Other strategies have not been implemented very frequently in the past, but were perceived by workshop participants as important strategies in the upcoming years. For instance, hedging allows traders to make contracts to purchase a product on a fixed date at a predetermined price. Dairy farmers could hedge both their milk price and their concentrate feed price, by hedging milk/feed or by selling a proportion of the milk produced on the futures market. This strategy is currently only applied by few dairy farmers in Flanders.

Table 7.2. Summary of most important future strategies per process

Process	Future strategies
Agricultural production	- Optimization by using technology (e.g. precision farming and other technological solutions) - Diversification (other activities on the farm such as on-farm selling or processing, agri-tourism) - Scale enlargement - Optimization of animal health management
Farm demographics	- Govern land availability - Tackle succession at an early stage - Labor flexibility schemes - (Inter)personal advice and coaching - Alternative financing and organisational models
Farm management	- Participation in activities to exchange knowledge with colleagues and advisors - Cooperation with other farmers - Preparing the farm for exit/succession: partnership farms when multiple generations are working together - Raise awareness/education on economic figures
Governance	- More stable policies with long term vision - Accommodate flexibility and variety - Govern land availability - Stimulate and regulate vertical and horizontal cooperation
Risk management	- Maintain financial savings for hard times - Member of a producer organisation or a cooperation - Have low debts or no debts at all to prevent financial risks - Use market information to plan activities regarding production and marketing

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	- Use production or marketing contracts to sell (part) of production - Cooperation with value chain actors such as processors, retailers and technology providers - Hedged (part of) my production with futures contracts - Have an off-farm job

7.11 CONCLUSION

During the last decades, the dairy farming system in Flanders has rapidly evolved from small-sized mixed farms towards fewer but larger farms that are specialized in producing milk in a highly intensive way. The large structural changes are illustrated by the decrease in number of farms but increasing total milk production. As scale enlargement of individual farms is ongoing, and overall milk production is increasing, the system is considered to be in the growth phase of the general adaptive cycle. After the abolishment of the dairy quota, intensification and scale enlargement have been supporting dairy farms to answer to decreasing margins, reinforcing the farms' robustness and ensuring the delivery of high quality products. However, farm household members and the typical capital intensive family farming model seem to encounter their limits, as high workload, changing societal opinion, low economic margins, volatile prices, frequent policy changes and extreme weather events are challenging the systems' capacity to maintain current practices. Overall, the resilience of the system is moderate. The high degree of intensification and the increasing scale of production are the main drivers for the relatively high capacity of the system to absorb shocks, but at the same time for its low flexibility and poorly performing resilience capacities adaptability and transformability. As literature argues that a system that is efficiently adapted to frequent specific (known) perturbations is likely to be more vulnerable to unexpected challenges (Cifdaloz et al., 2010; Folke et al., 2010), the current strong focus on robustness might form a pitfall for the general resilience of the Flemish dairy farming system.

Further, the presence of attributes that enhance resilience is low to moderate. The attributes *openness* and *tightness of feedbacks* were assigned a moderate score, and can be illustrated by the high degree of self-organization and the connections with outside actors that both enable the system to quickly react to crisis situations. The *modularity* of the system is on one hand reinforced by the high capacity of the system to absorb shocks but on the other hand being pulled by the low flexibility of the system. *System reserves* are rather low; because, among others, future succession rates are uncertain, current profitability is low, and nitrogen levels in soil and water are high while soil organic carbon stocks are low. Low functional diversity is a main disadvantage of a capital-intensive system where technological inputs can result in a locked-in situation, while low response diversity is the result of robustness-oriented strategies. Furthermore, current policy configurations foster robustness but support adaptability and transformability in a passive way: implementation of policy measures only results in supporting robustness of the farming system

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despite policies goals being well-intentioned to improving all three resilience capacities. More decentralized policies and/or a higher degree of spatially and temporary flexible policies could improve the system's *diversity* and *modularity*.

Future strategies for improving the system's resilience include farmers to be better informed about risk management portfolio's and alternative production systems, policies to become more stable and created within a long-term vision, land availability to be organized by the government, succession being tackled at an early stage by considering alternative financing and organizational models, adoption of innovations supporting eco-efficiency, and stimulation of both horizontal and vertical cooperation to improve economic viability of milk production in Flanders. Additionally, more attention is needed for providing a viable income and good quality of life for the dairy farmers and farm households, as these functions are considered to be of crucial importance for maintaining the system's resilience but perform inadequately.

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8 CASE STUDY GERMANY

Franziska Ollendorf and Franziska Appel

8.1 ABSTRACT

The farming system of the German case study region the "Altmark" is heterogeneous but mixed and arable farms are most prevalent. The biggest share of land is cultivated by large-scale corporate crop farms. However, many small-scale family farms do exist, too. The Altmark region is determined by poor soils and increasingly affected by droughts, both contributing to rather low yields in the area. Besides, stakeholders perceive financial viability of the farms and institutional factors such as a high degree of bureaucracy, frequent policy changes and a very low level of regional infrastructure as main challenges for the farming system. Nevertheless, the main functions of the system, such as ensuring sufficient farm income, delivering high quality foods, and maintaining natural resources in good conditions, are considered to perform moderately to well. The lowest functionality is ascribed to the functions quality of rural life and regional infrastructures. The overall resilience capacities in the Altmark are estimated to be low to moderate (Figure 8.1). Currently, adaptability is perceived as the strongest resilience capacity; farmers manage to keep the status quo and to adapt to continuous changes, as for instance new technological requirements and changing regulations. They have already proved their adaptability capacities during the major process of system transformation which started after the German reunion. While diverse policies support and foster robustness and partly adaptability, there is no distinct focus on increasing transformability capacities. The presence of attributes that help the system to improve its overall resilience is generally estimated to be low to moderate. While openness, diversity, and modularity are regarded to be moderately present in the system, particularly tightness of feedback and system reserves comprise attributes which presence is estimated low. Future strategies can directly respond to these deficiencies and include risk management strategies such as financial and logistical support for climate change adaptation including the development of adapted agricultural practices as well as improved information flows, governmental aspects such as the continuity and transparency of regulations, and a determined investment in rural infrastructure.

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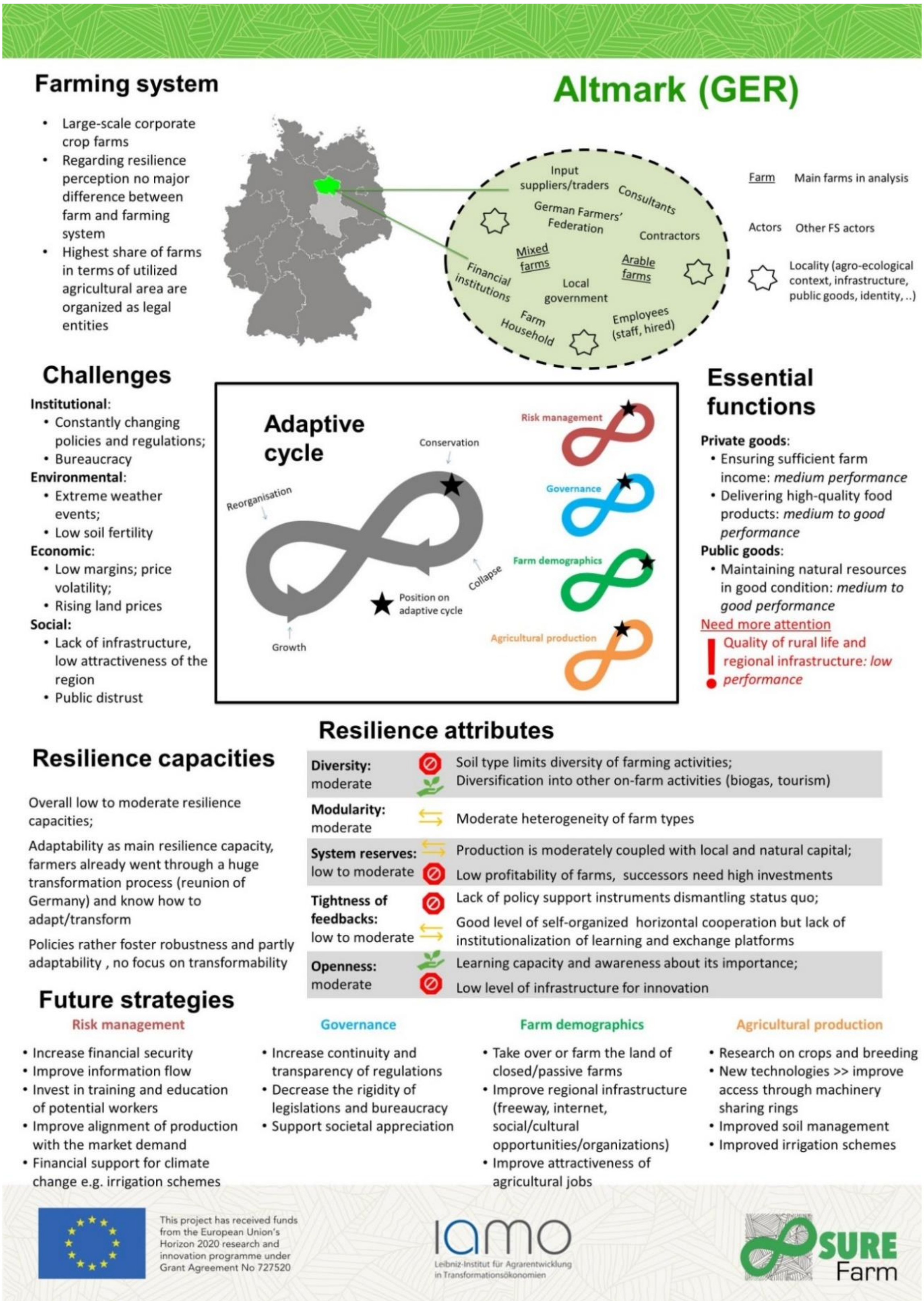

Figure 8.1. Factsheet synthesizing resilience of the current faming system in the Altmark.

8.2. FARMING SYSTEM

The region of the German case study (CS) is called “Altmark”. It is located in the North of the German federal state “Sachsen-Anhalt,” which is in the East of Germany, and consists of the two districts “Stendal” and “Altmarkkreis Salzwedel”. The structure of the agricultural production system reflects the legacy of large-scale agricultural structures from the former German Democratic Republic (GDR) but also comprises smaller and family farms[2]. Thus, farm size is heterogeneous (Appel and Balmann, 2018). During several phases, the political regime of the GDR forced a collectivization of land. Farmers were urged to contribute their land and animals to the “Agricultural Production Cooperative" (Landwirtschaftliche Produktionsgenossenschaft, LPG) so that very large farms of pooled land as well as large herd sizes were established. While the overall economic performance of the LPGs was low they played an important socio-economic role in the rural areas of the GDR as they were the main employer and also in charge of several public services (Martens, 2010). After the reunion, the organizational form of LPGs came to its end but large-scale farming was continued. In most cases, LPGs were converted to legal entities (cooperatives or holdings) but some individual smaller (family) farms were established, too. There has been a quick adjustment to the new political and economic requirements and a remarkable rapid increase in productivity took place. This, however, has been achieved through broad means of modernization and rationalization such as a focus on exclusively economic functions of the farm. In that process, farm employment has been drastically reduced (in some cases up to 90%, Martens, 2010). Other employment opportunities were almost not available in the rural areas of Eastern Germany and a process of marginalization of these regions begun.

The main products remained similar: cereals, oil seeds, potatoes and sugar beets as well as meat and milk. Today, most of the utilized agricultural area is used by mixed farms, while the highest number of farms are the arable farms. In average the mixed farms are larger farms compared to arable farms. In terms of utilized agricultural area, corporate farms have the highest share but in terms of the number of farms, the family farms comprise half of the share. This is reflected in the fact that most of the corporate farms have a large farm size. Compared to other districts in the federal state, with 27% the Altmark has a high share of grassland, the soils are rather poor, and the yields of the arable crops are rather low. The Altmark also comprises almost half of the cow population of the federal state[3].

[2] For a detailed description of typical farm types in the Altmark see Bijttebier et al. (2018): SURE-Farm D3.1 Report on current farm demographics and trends.
[3] This paragraph is partly borrowed from Kampermann et al. (2019): FoPIA-SURE-Farm Case-study Report Germany.

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Figure 1 presents the social composition of the Altmark's farming system. The inner circle shows the actors which influence the farming system and are equally influenced by the farming system while mutually influencing each other, too. The actors "farm", "farm household", "employees", "contractors", "peers", "neighbors", and consultants are part of the inner circle. "Farms" and "farm households" are providing jobs in the farming system which are carried out by "employees" and "contractors". "Contractors" are service providers and next to the family members and employees an important part for the business of the farming system (e. g. for large-scale producers, suppliers). Service providers are essential because they deliver a certain quality of service and know-how and therefore belong to the inner circle. Although farms in the Altmark are usually organized in farm unions, which often also provide trainings and foster information sharing in addition to their main function as lobby group, private consultants play an important role for the farming system. Consultants provide farmers with knowledge, advice and technical support. They are equally shaped by farms' performance since these are their main clients.

The outer circle represents the actors which are influencing the farming system in the Altmark but are only scarcely influenced by it. In the Altmark region actors like "suppliers", "technology providers", and the "construction sector" are providing the farming system with inputs and refinement. "Policy makers" and the "local government" are steering the farming system through a given legal and regulatory framework. The farmer unions (e.g. Deutscher Bauernverband, Deutsche landwirtschaftliche Gesellschaft) has influence through representation of interests on policy makers. Besides, NGOs, media, and consumers can act as opinion makers and advocates for or against particular agricultural practices. The "agrarian social system" covers the farmers in case they are not able to work because of sickness and physical inability etc. Finally, actors from the field of "R&D" are also part of the system since they deliver new ideas for innovation in a farming system.[4]

[4] Description of the farming circles partly borrowed from Kampermann et al. (2019): FoPIA-SURE-Farm Case-study Report Germany.

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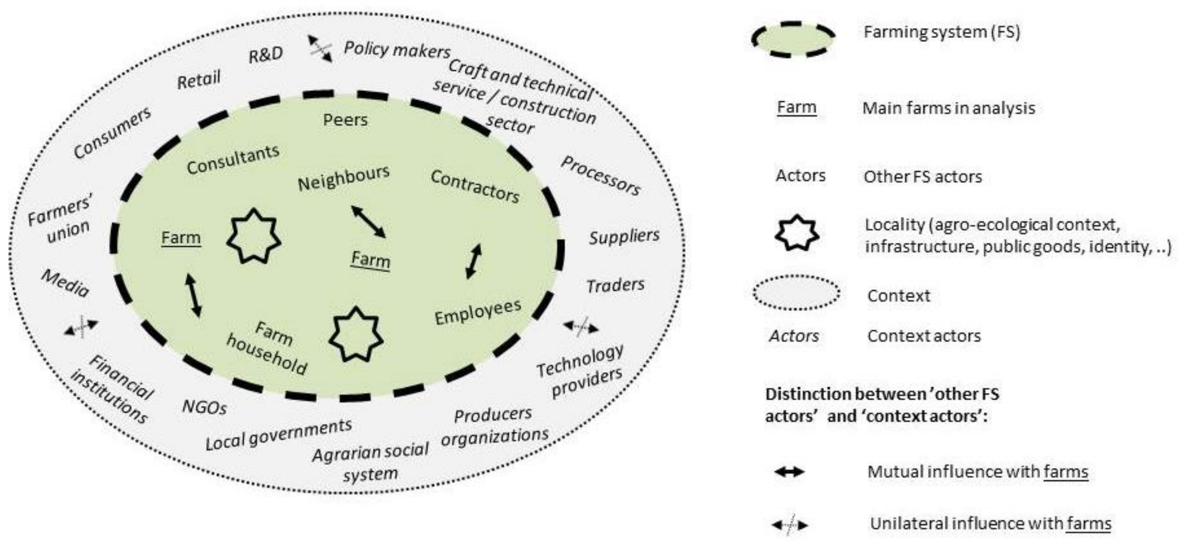

Figure 8.2. Farming system and context actors in the German case study region the Altmark.

8.3. CHALLENGES

8.3.1. Present challenges for farmers and farm households

The farm survey gives insight in farmers' perceptions of challenges for their farms. The survey comprises the following farmer groups: arable farms, dairy farms, pig farms, farms with other grazing livestock, mixed farms and the group "other types of farms" (wood, fuel, grassland, and viticulture). All farmer groups except mixed farms perceive social challenges (public distrust and low social acceptance of agriculture) as the biggest challenge. Accordingly, social challenges have the highest average score covering all farm types (4.8), followed by institutional challenges (4.4), economic (4.1) and ecological (4.0). This pattern also holds for almost all individual groups.

Looking into the challenge perceptions within the groups, dairy farmers have the highest perception of social challenges (5.6) among all farmer groups. Moreover, they have the highest perception of challenges in general (4.9 total challenge perception). They rank institutional challenges (5.0) higher than economic (4.7) ones and ecological challenges as lowest (4.2). The group other farmers has the lowest perception of challenges in general (3.8) among all groups. Yet, social challenges for them, too, rank highest (4.3), followed by institutional (3.9), economic (3.8) and ecological challenges (3.2). Arable farmers, too, rank institutional challenges slightly higher (4.2) than economic (4.0) and ecological (3.9) challenges. Pig farmers have the lowest perception of economic challenges among all groups (3.4) whereas institutional challenges rank quite high (4.5) which goes in line with below presented findings on animal welfare regulations. Mixed farmers have the lowest perception of social challenges (3.4) whereas ecological challenges

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rank highest (4.9), what is the highest ecological challenge perception among all groups. Due to the small number of the survey population in the respective farmers groups, statistical tests were not applied.

Learning and demographic interviews have been conducted with arable and dairy farmers. The results allow a deeper insight into the farmers' perceptions of challenges. In the Altmark, social conditions which are particularly affecting the farming system negatively and which make it difficult to recruit qualified farm successors and skilled farm workers include a negative population growth, a poor regional infrastructure (including access to financial services or internet connection) and not very attractive living conditions. Furthermore, political and societal populism are regarded to contribute to a bad image that society would have developed towards farming and which would have increased pressure on them. But a more organized civil society, too, can be a source of pressure from the farmer perspective. For instance, intensive pig farming is facing an increasing resistance of society and requires the system to adapt or even transform. Arable farmers mentioned problems with more strict regulations on the use of fertilizers and pesticides, a rigid bureaucracy and the often changing and seemingly arbitrary implementation of regulations as major institutional challenges. Several interviewees mentioned the competition with non-German producers as one main economic challenge whereas simultaneously new foreign investments in the region would lead to rising land prices and further challenge the system. In the Altmark, the number of smaller dairy farms is continuously decreasing, especially during periods with low milk prices. At the same time, medium and large scale dairy farms become the more dominant form of dairy production in the region. Some interviewees state the concern that this might lead to an increase of water pollution in the region. At this point of time, however, for some farms the access to water is more of a problem than its quality. This is due to the increase of droughts and the linked dependency from irrigation schemes. Many farms do not possess secured water extraction rights. Water extraction rights in the Altmark are still based on historic distribution patterns and unequally distributed among the farms. Therefore, in the Altmark, water extraction is both, an institutional and an environmental problem. Another environmental challenge are the sandy soils which, impaired by extreme weather events such as frost, drought, strong rains and floods, became more frequent during the past years. This seemingly contributed to the perception of a strong environmental vulnerability of agriculture in the region.

The AgriPoliS focus group workshop on labor issues provided another opportunity to gather more detailed insights into social challenges facing the farms in the Altmark. For instance, being a family farmer means high investment in staying in the area since social and cultural opportunities are relatively low and the overall quality of life in the rural areas is perceived to be decreasing – schools and doctors are difficult to access, the compensation of agricultural jobs is too low and there is a lack of jobs outside of agriculture. In addition, due to the poor infrastructure it is difficult

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for labor to commute to the nearest "industrial zone" (small city) on a daily basis for work. The following bullet points represent the most challenging aspects that have been discussed in the workshop:

- Jobs: lack of industry (highly paid) and other non-agricultural jobs
- Poor infrastructure: freeway/commuting possibilities, internet, availability of doctors, schools
- Social/cultural opportunities: lack of cultural activities in the area
- Demographic change: general drop in birthrates, migration towards less marginalized areas

In sum, farms are faced by a broad range of challenges concerning farmers' and workers' living conditions and the efficiency of the farm. Unfavorable environmental conditions, potentially worsening in the future, economic and institutional obstacles as well as poor living conditions make the farming in the Altmark very unattractive. Hence, both finding qualified labor and appropriate successors is one of the major challenges for the current farms.

8.3.2. Present and past challenges for the farming system

The AgriPoliS focus group workshop, the ResAT tool, and the FoPIA workshop provided information on challenges at the farming system level. The discussion during the AgriPoliS focus group workshop revealed the shortage of qualified labor and how it is putting pressure on farms and the whole farming system in the Altmark. Participants of the AgriPoliS workshop stated a decline of quality of trainees in comparison to 20 years ago. The sector is unattractive due to long and irregular working hours and low pay off in comparison to non-agricultural jobs. Besides, the bad image of agriculture – mostly transmitted by media – is perceived to contribute to the unattractiveness of agriculture. Confirming the findings from the learning and the demographic interviews, participants pointed to the unattractiveness of the whole region due to its poor infrastructure and the shortage of non-agricultural jobs. The region has seen a large exodus after the reunion which has contributed to its marginalization. Besides, farmers complained about high costs of new technologies and policy makers not paying enough attention to farmers' needs.

Focusing on institutional challenges, the ResAT revealed concerns that land sales and rental prices may become too high and that productivity would decrease due to deteriorating environmental conditions. The decreasing societal acceptance of large conventional farms and current production systems as well as the increasing risk of costly regulations have been identified as challenges for the agricultural system, too.

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The FoPIA-SURE-Farm workshop dealt with challenges that the farming system faced in the past. Most of them, i.e., environmental and economic challenges, still remain relevant, and hence past experience can serve as a basis for future resilience strategies. Economic challenges linked to external factors were, for instance, the financial crisis in 2009 which led to strongly fluctuating market prices of agricultural products. Another example is the introduction of minimum wages in Germany in 2015 which improved farm workers livelihoods but put more pressure on the farms' financial reliability. In several years in the past, environmental challenges such as extreme weather events like floods and droughts challenged agricultural production in the region. Factors and developments linked to institutional innovations and changes have impacted agricultural production in the region in the past. While political regulations are continuously changing, it remained a challenge for farmers to understand the requirements of the respective regulation and how to apply for the financial support for its implementation. This becomes particularly problematic concerning regulations targeting animal welfare, as for instance the framework for animal husbandry 2014. Participants describe them as very cost intensive and difficult to implement. Other past regulations that have been highlighted as strongly having impacted the farming system are the agricultural reform in 2005 or the milk quota abolishment in 2013. Participants estimate the scheduled stop of Glyphosate and seed dressing usage to affect the sector strongly.

8.3.3. Concluding remarks on challenges

Table 8.1. synthesizes the challenges identified across methods. Most of the challenges listed under "farming system (past challenges)", which were collected during the FoPIA-SURE-Farm workshop and therefore were discussed regarding the past, are also considered to be of major relevance in the present and for future.

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Table 8.1. Summary of challenges across methods. The table continues over three pages.

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Arable farms	3.9 (least relevant)	4.0		4.2 (most relevant)
		Dairy farms	4.2 (least relevant)	4.7	5.6 (most relevant)	5.0
	Shocks	Learning interviews	frost, drought, extreme rain and floods	prices, trade agreements		Changing and seemingly arbitrary implementation of regulations
		Demographic interviews				
		AgriPoliS focus group				
	Long-term stresses	Learning interviews	Agriculture is vulnerable to weather	Competition with non-German producers, land market, labor shortage	Populism, poor regional infrastructure, Negative media attention	Rigid bureaucracy
		Demographic interviews	Due to an increase in farm intensity, the region has to deal with water pollution		Living conditions in the countryside, qualified farm successor, bad image in society	Deficits in public services in the countryside

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			Environmental	Economic	Social	Institutional
		AgriPoliS focus group	Different approach towards fertilizing lands followed by arable and dairy farmers	The qualified labor shortage is putting pressure on farms in the region, technology is expensive, lack of high paid jobs	Unattractive agricultural sector (long and irregular working hours), low pay off in comparison to non-agricultural jobs, bad image of agriculture mostly due to media (as e.g. being scapegoat for climate change)	
Households	Shocks	Demographic interviews				
	Long-term stresses	Demographic interviews		Access to capital	Public distrust, poor living conditions in the countryside	
Farming system	Shocks	ResAT	New extreme weather events			
		AgriPoliS focus group				
	Long-term stresses	ResAT	Rather poor soil quality and this results in	Concerns that land sales and rental prices may become too high. Less productivity	Negative population growth and thereby a decreasing agricultural	Decreasing societal acceptance of large conventional farms and current production

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			Environmental	Economic	Social	Institutional
			rather low yield levels in arable farming. Climate change and low annual rainfall.	because of environmental problems.	workforce, generational	systems, increasing risk of costly regulations
		AgriPoliS focus group		Low profitability, restricted access to credit, high land prices technology is expensive	Ageing farm population, poor infrastructure in the Altmark, shortage of non-agricultural jobs, regional exodus post-reunification	Policy makers not paying enough attention to farmers' needs, agriculture no longer taught in schools
Farming system (past challenges)	Shocks	FoPIA-SURE-Farm	Weather extremes (droughts and floods)	Fluctuating market prices of agricultural products		Shift from coupled to decoupled CAP payment
	Long-term stresses	FoPIA-SURE-Farm	Access to Water (unequal distribution of right to use the water canals), sandy soils, climate change, dry summers and wet winters	Farmers have a relatively low own capital, infrastructure of value chain of organic products, low economic performance per hectare, low wages	Decreasing number of availability of wage laborers/ successors, bad internet connection, availability of qualified and educated working force	Continuous change in policies and regulations

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8.4. OPPORTUNITIES

8.4.1. Present opportunities for the farming system

The AgriPoliS focus group workshop provided insights into currently existing opportunities. One economic opportunity that has been discussed is an improved alignment of the product line with market demand instead of continuing producing what one used to always produce just because traditionally it has been always produced. Besides, there is a trend of market concentration in the dairy value chain. This leads to a perceived imbalance in power between producers on the one hand and processors and traders on the other hand. The majority of dairy farms sell their milk to large dairy processing companies. Only a very small group of farms is collaborating and tries to avoid selling to these large dairy factories. It is perceived that farms have minor potential to specialize in label products. Hence, the transformation to organic milk production is regarded as more realistic and could be an opportunity for larger farms, too (only small farms have converted to organic farming until now). A social opportunity would be to focus on engagement in partnerships with colleagues and institutions in the region. For instance, since young generations almost don’t have any interference with agriculture anymore and have a negative perception about it, cooperation with schools and the joint conduct of some educational projects could fill this gap and help to change the sectors’ bad image. As mentioned above, one major challenge for the farming system in the Altmark is the lack of skilled labor. Both, corporate and family farmers, stated the willingness to invest in training and education of potential workers, particularly refugees which were located in the region and who often are interested in the sector. However, since their status and their right to work are uncertain, farmers refrain from engaging in their education. In sum, if lawmakers would revamp the laws around the right to work and exhaust institutional opportunities, there could be better possibilities to respond to the labor shortage. Another institutional opportunity is the simplification of the granting of water extraction rights. Many water canals for irrigation are from pre-unification time, and owned by corporate farms, resulting in unequally distributed water canals and limiting the access to water for some farms. The simplified access to extraction rights could be combined with the establishment of centralized water reservoirs, which would be an important environmental opportunity in the region (flat and characterized by drainage, trench system). This might be important to face unexpected droughts. Farmers mentioned to be flexible for such an innovation. However, government payments should compensate farms that are willing to invest in such technologies.

8.4.2. Past opportunities for the farming system

During the discussion in the FoPIA workshop, a number of past opportunities have been highlighted. Past and long-term economic opportunities that have been identified include, among others, the use of niche products and the development of marketing strategies for them, measures which aim to increase wages. Regarding social dimensions, opportunities which were deliberated and which were seen to have shown some effects on the system are the improvement of working conditions through technological progress or the implementation of flexible holidays.

Demographic interviews, too, revealed a number of past opportunities for the farming system. For instance, in some particular cases, direct marketing helped to improve economic performance. Nevertheless, due to generally low purchasing power in the rural area of the Altmark, direct selling of produce remains challenging. Furthermore, the need for investments, e.g. in new technologies like milk vending machines, hampered the process, too. Main past opportunities for growth occurred when other farms in the region exit. Regarding this, different options like a purchase or leasing of the land are possible but the prices are high. As an alternative to this, some respondents told that they cultivate the land of closed farms. In some of these constellations, the land officially remained in the hands of the former farmer who pays for the service or the harvest is shared. This form of cooperation is an option to better use the capacity of machines and improve cost structures.

8.5. FUNCTIONS

8.5.1. Farmers and farm households

The farm survey revealed that farmers from arable farms consider farm income as most important function followed by the delivery of quality food products. The maintenance of natural resources and the provision of employment and good working conditions were ranked in the middle. For dairy farmers, there is a similar pattern: They consider the function of farm income as most important, followed by the delivery of quality food. Ensuring animal welfare ranks in the middle but behind the functions natural resources maintenance and the provision of employment and good working conditions. All farmer groups (except "others") rank attractiveness of rural areas/agro-tourism and the delivery of bio-based resources as the least important functions; for "others" the less important function is animal welfare.

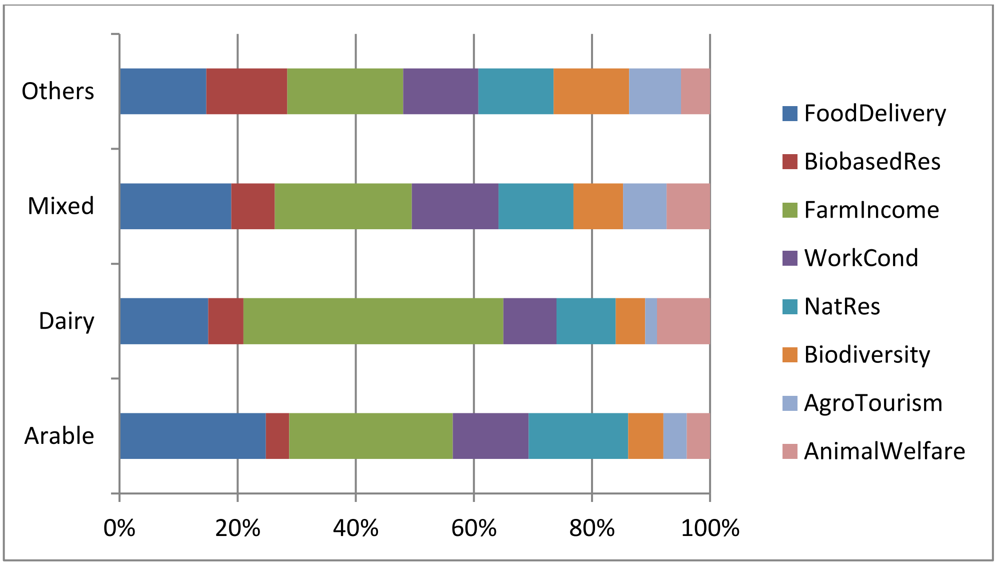

Figure 8.3. Essential functions (averages) according to the farm survey.

The learning interviews provided more detailed insights into farmers' perceptions on the function of agriculture. For many interviewees, farming must be profitable enough to continue, but there is the general assumption that no one would enter farming because they want to be rich. Farmers in the region have good environmental practice (e.g. there were no real changes when greening measures were implemented). For them, the public good is to provide good food, and sustainability is part of their business model.

Similarly and confirming the above findings, in the focus group on risk management strategies, private functions of agricultural production that were mentioned include the generation of household income and the production of foods. Public functions that agriculture in the Altmark region potentially could comprise include ecological services, the reduction of chemicals, and conservation of diversity.

8.5.2. Farming system

The FoPIA-SURE-Farm workshop gave insights into stakeholders' perceptions regarding essential functions of the farming system. Farmers, researchers and consultants, as well as politicians and NGOs were asked to rank functions of the farming system. Other participants than farmers score the function food production by highest whereas farmers clearly attribute most importance to economic viability. Natural resources receive almost equal importance from all three groups and rank third highest. Animal health and welfare is scored higher by politicians and NGOs than by farmers who score it lowest among all functions. Figure 8.4. gives an overview of the stakeholder rating of the farming system's essential functions.

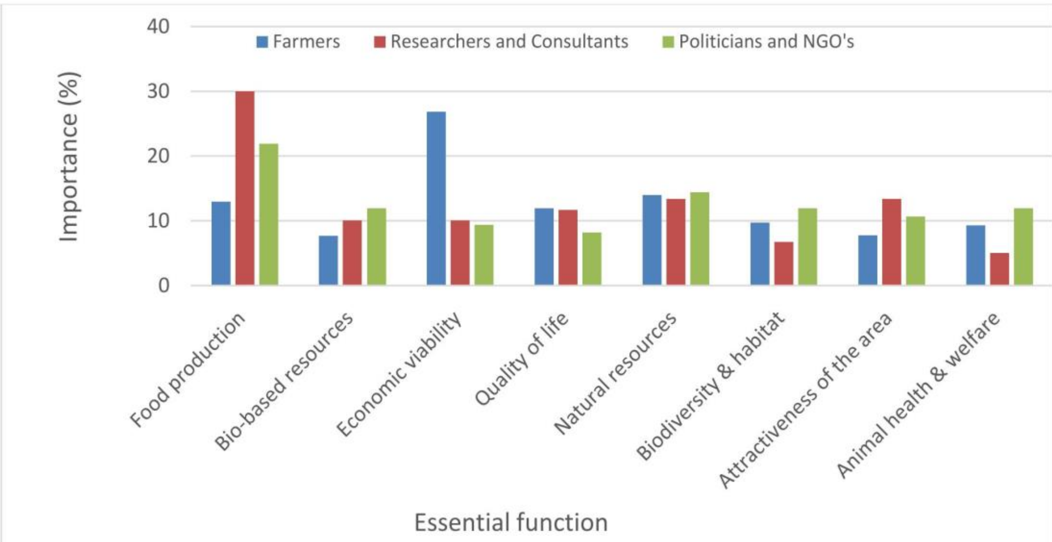

Figure 8.4. Bar graph with scoring per EF, aggregated by stakeholder group. 100 points needed to be divided over eight functions.

In particular the function "improve quality of life" was criticized by participants due to the low wages which are payed in the agricultural sector. The consensus of the plenary discussion was that the farming system is working, but rather not sustainably because the wages and farm income were not adjusted over the years to the increased value upstream of the value chain.

Performance: From the three most important functions, food production, economic viability, and natural resources, natural resources scores best in performance whereas economic viability scores lowest. Quality of life is scoring lowest in performance among all functions while having an average importance of the functions, which indicates a bottleneck for the Altmark region. Both private and public goods scored equally in their performance on average.

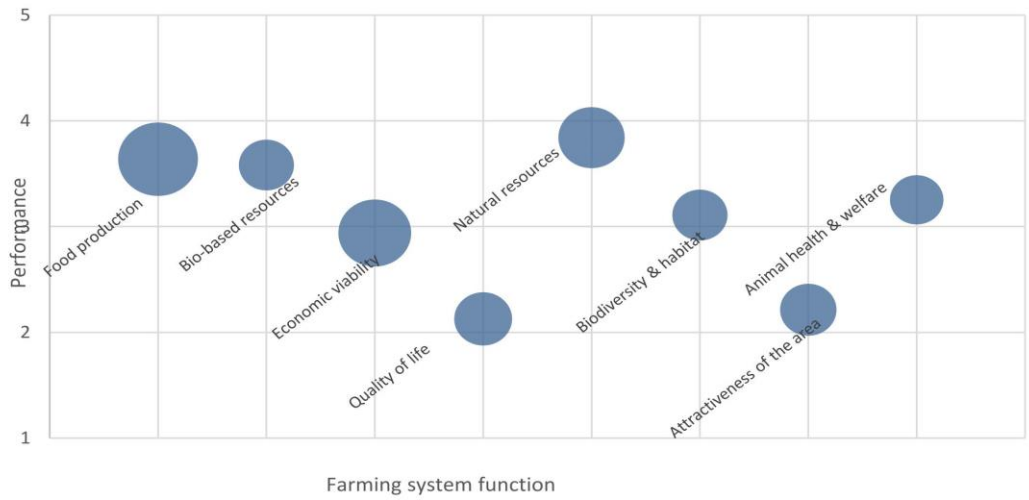

Figure 8.5. Bubble graph presenting averaged scores on performance of functions (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.

The performance of the indicators is scored between one and five points, while five points is the score for very good performance and one for very poor performance. “Milk production”, “water quality” and “soil quality” are indicators which show both, good performance and a high importance at the same time. “Production of biogas” is the best performing indicator but scored very low in importance. “Gross margin” and “cereal production” are indicators with a medium performance but scored as important once. Indicators with a low performance but a high importance are “internet connection” and “wages”.[5]

[5] Paragraph based on Kampermann et al. (2019): FoPIA-SURE-Farm Case-study Report Germany, p. 14.

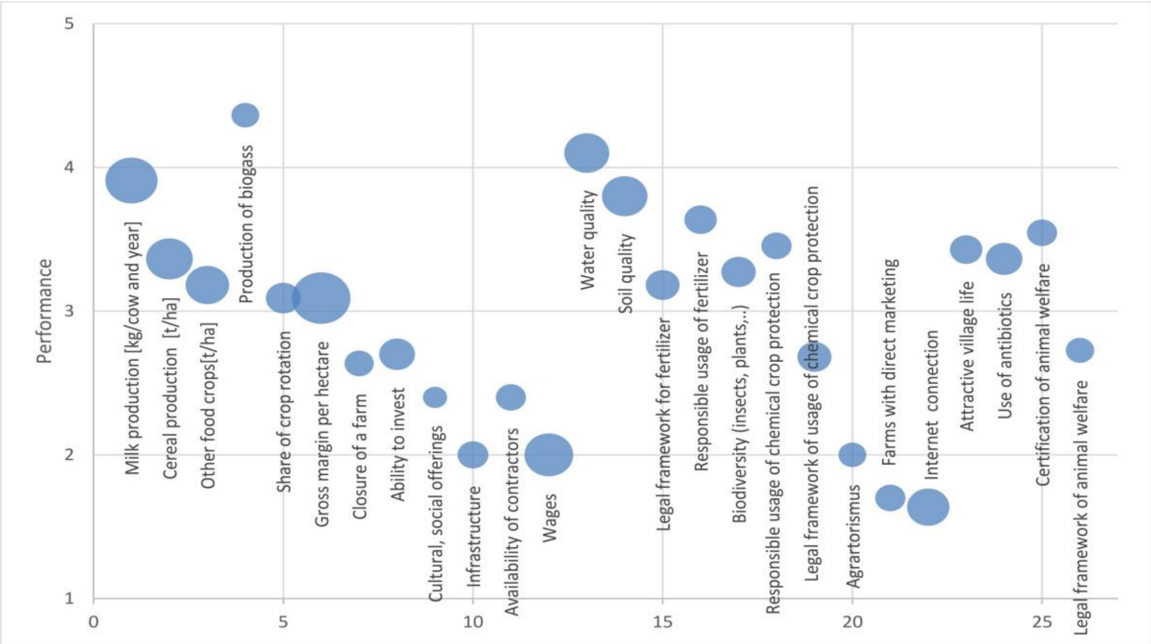

Figure 8.6. Bubble graph presenting averaged scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.

8.5.3. Ecosystem services assessment

The ecosystem services (ES) assessment calculates the deliveries of private and public goods by the farming system. Figure 8.7. and Figure 8.8. depict the comparison of the farming system with the performances in the rest of the region. By comparing the delivery of functions in the farming system with the rest of the region it is possible to understand if the farming system plays a role in increasing or decreasing the respective function in the region.

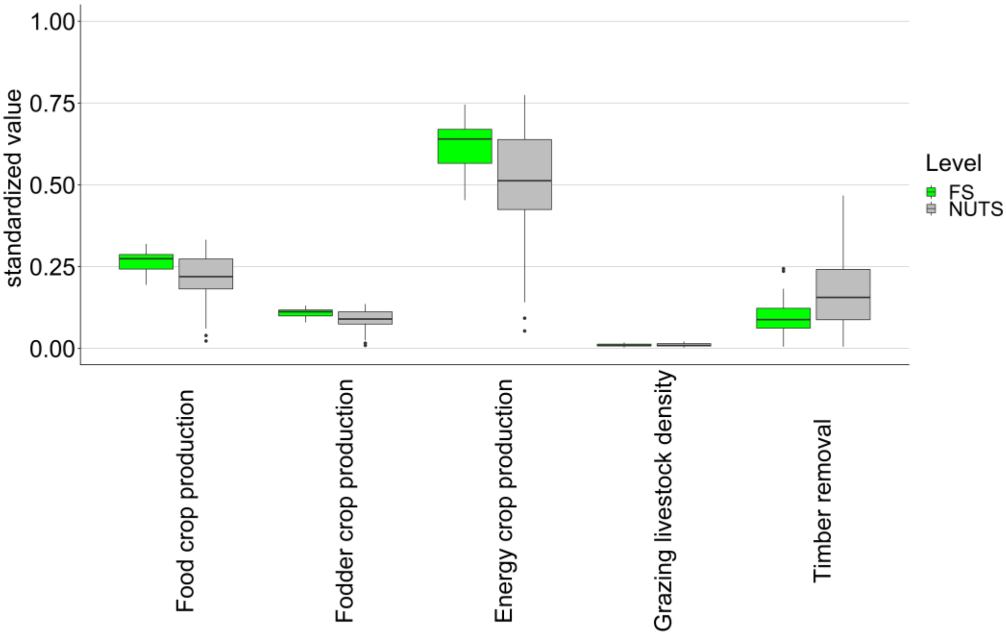

Figure 8.7. Delivery of private goods in the Altmark case study. The boxplots represent the variability of the standardized proxies of private goods within the 10km-x-10km squares composing the farming system (green boxes) and the variability of the standardized proxies of private goods within the 10km-x-10km composing the NUTS3 region(s) in which the farming system is contained (grey boxes).

Concerning private goods (Figure 8.7.), it is not surprising that the farming system have very low scores in *grazing livestock density* (~0 – on a scale of 0 to 1) and *fodder crop production* (~0.12) as this plays a minor role in the farming system of the Altmark region and because the animal production is not represented in the JRC data used for the analysis. *Food crop production* (~0.26), on the contrary, is slightly higher than the rest of the region, and represents the main focus of the Atmark's farming system. The highest score is reached for *energy crop production* (~0.7). Since 2009, the Altmark has been assigned as one of 25 so-called bioenergy regions in Germany because it offers a huge potential of biomass from several sectors, but dominantly by the farming system. Since then the bioenergy production has been continuously extended (cf. Appel et al. (2016)) and is slightly higher compared to the rest of the region, probably because of the presence of hedges. *Timber removal* is quite low (~0.12) because the farming system is based on arable land and grassland, while forests are used by other sectors.

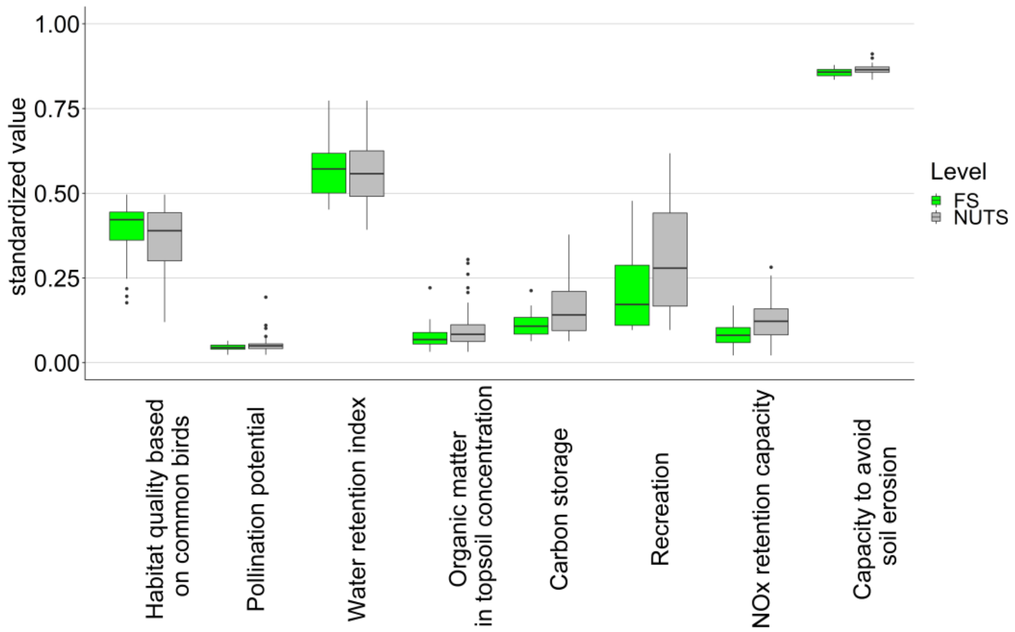

Figure 8.8. Delivery of public goods in the Altmark case study. The boxplots represent the variability of the standardized proxies of public goods within the 10km-x-10km squares composing the farming system (green boxes) and the variability of the standardized proxies of public goods within the 10km-x-10km composing the NUTS3 region(s) in which the farming system is contained (grey boxes).

Concerning public goods (Figure 8.8.), the performance is lower than the rest of the region for organic matter in topsoil concentration, carbon storage, recreation, NO_x retention capacity and capacity to avoid soil erosion. We agree with these results. NO_x retention capacity is higher in forests than on arable land. Also, large-scale agriculture provides more monotonic landscape than e.g. forests and therefore is less attractive for recreation. The bird habitat quality may benefit from the mix of arable land and grassland. Carbon storage remains low in agricultural land as there is a very fast cycling of organic carbon (contrary to forest). Capacity to avoid soil erosion is slightly lower than the rest of the region, and this is due to the arable farming on large fields with a low share of hedges that protect soil from erosion. Here we would argue that the difference between the farming system and the region could be even larger. Finally, pollination and water retention index do not show a significant difference with the rest of the region.

8.6. RESILIENCE CAPACITIES

8.6.1. Farmers and farm households

In the farm survey, farmers in average rated their transformability higher (4.2) than their adaptability (4.2) and their robustness (4.1). Anyhow, the group levels show the differences regarding these self-assessments. While arable farmers and mixed farmers score transformability higher than the other two capacities (4.8 and 4.9 respectively), dairy farmers and others rate adaptability highest (3.6 and 4.8 resp.). Hence, the two capacities leave behind robustness. Nevertheless, while conducting statistical tests like factor analysis with the survey data, scales were not loading into three different factors indicating that – likely due to the small number of respondents – there might not be a clear distinction between the three resilience capacities in the survey.

In the learning and demographic interviews, a number of resilience capacities of farmers in the Altmark became apparent. For instance, during the extreme droughts, crucial inputs (e.g. fodder) became scarce on the local market. Some farmers indicated that they increased their robustness towards undesirable market situations by storing products and feed. Another strategy that has improved robustness for large farms is the introduction of biogas plants which help the farmers to compensate temporarily low milk prices.

Growing and experimenting with new crops is important for farmers' adaptability to new environmental conditions. In the interviews, a number of successful cases of have been reported. Similarly, some farmers gave account on their activities to introduce new technologies to continue farming under conditions of extreme weather events and labor shortages what also shows their adaptability capacities. In the interviews, the difficulties to cope with the complex bureaucratic system and other challenges like climate change have been discussed. Thereby, the need to become more pro-active in planning and to distinctly allocate more time and other resources to it, have been highlighted several times. Accordingly, respondents commented on their efforts to spend more time in the office than on the field. This endeavor indicated yet another capacity of farmers in the Altmark to adapt to new requirements in the system. In times where the farming system faces multiple pressures and economic, environmental, and social dimensions of sustainability have to be conciliate and brought in line, farmers in the Altmark perceive a strong social pressure to be responsible for this. Some interviewees commented on their feelings to be targeted by negative media campaigns on conventional agriculture. As a response to this, they increasingly invest in public relations in order to stop what they perceive as populist propaganda. This strategy indicates their capacity to adapt to social challenges in the system.

Farmers in the Altmark perceive their capacity to transform rather low but one success story is the implementation of biogas plants on farms. With the implementation of such plants, working practices on the farm alter. While keeping the established parts of the farm, they are complemented with an additional income source that requires new proceedings but improves financial reliability of the farm. Besides, farmers mentioned the problem of the fast changes in the political framework that would negatively affect their capacities to transform. From their perspective, under conditions of regulatory insecurity, it is even more difficult to conduct a solid planning of transformation.

8.6.2. Farming system

Strategies:

During the FoPIA workshop, strategies' of the indicators "gross margin", "animal welfare", and "wages and income" and their contribution to resilience capacities have been assessed. One main feature is that almost all strategies are perceived to affect all the three resilience capacities mainly positively.[6] For the indicator "gross margin", this particularly holds for "Extension of rapeseed" which positively contributes to the three resilience capacities almost to the same extend. For "animal welfare", "Labelling requirements" contribute moderately to all three capacities and regarding the indicator "wage", "working conditions" contribute quite well to all three capacities of the indicator's resilience.

Robustness: The strategy "working conditions" for farmers as well as for employees shows highest impact on robustness among all strategies for the three indicators. Besides, the implementation of the strategies "Minimum wage" for employees, which has been introduced in overall Germany in 2015, "Extension of rapeseed production" and "German Renewable Energy Sources Act (REA)"[7] also show high effects on the robustness of their respective indictors.

Adaptability: "Agricultural Investment Funding Programme (AFP)"[8], "Order on production animals", and "Working conditions" are the strategies which show the highest effect on the adaptability capacity of the system. The first strategy gives economic incentives through political regulations to adapt the production. The second strategy implies farmers' responses to legal innovations regarding animal welfare that force the system to adapt but not to transform. The third strategy, as mentioned above, implies improvements regarding on-farm working conditions for both farmers and employees.

Transformability: "Minimum wage" shows the highest contribution to transformability among all strategies for the three indicators whereas it doesn't show high impact on the adaptability of the system. Due to the introduction of a minimum wage, some particular production branches (as for instance sow keeping) became unprofitable and could not be maintained. Under the new wage conditions, even an adaptation strategy would economically not be viable. Therefore, processes of transformation took place, as for instance the abandonment of the production branch (e.g. sow keeping), leading to the transformation of the farm or even the total cessation of operations. The EU's past ban of conventional battery cage for poultry, especially laying hens ("Ban caged poultry"), and "Extension of rapeseed production" as a result of REA (production of bio diesel) also show a fairly positive effect on the transformability capacity of the system. A "stop of investment" would be a

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[6] Looking at the results, there are some indications that participants did not completely familiarize with the concept and tasks of the workshop. This might have led to a partial distortion of results. For example, REA (see FN below) and its biogas support encouraged transformation from agriculture to energy industry. But in future, because of the 20 years of guaranteed feed-in compensations, it will still contribute to the robustness of agriculture, too. Despite this fact, REA's contribution to transformability has been rated extremely low by participants.

[7] "The REA implies regulations which are economic incentives for farmers to extent bio-based resources. The economic incentive is due to financial support of the government for bio-resources production for electricity generation. This led to an increase of the rapeseed production area, which had a financial benefit, especially for the Altmark region" (Kampermann et al. (2019): FoPIA-SURE-Farm Case-study Report Germany, pp. 19f.).

[8] The Agricultural Investment Funding Program (AFP) is the central program for promoting investments in agricultural holdings in Germany. The focus was on supporting investment measures for a competitive, sustainable, particularly environmentally friendly and animal-friendly agriculture with the general approach "public funds for public services" (own translation, retrieved from https://alff.sachsen-anhalt.de/alff-sued/landwirtschaft/agrarfoerderprogramm-afp/, last accessed on 1/11/19).

strategy motivated by new legal requirements or civic protests against a particular production practice, for instance. In some cases, permits for new buildings are not provided so that the whole production branch cannot be kept up and a complete transformation becomes necessary. “Stop of investment” contributes to the adaptability but counteracts the transformability of the system. At the same time, it does not contribute to robustness because the current performance of a system cannot be maintained in the first place. “

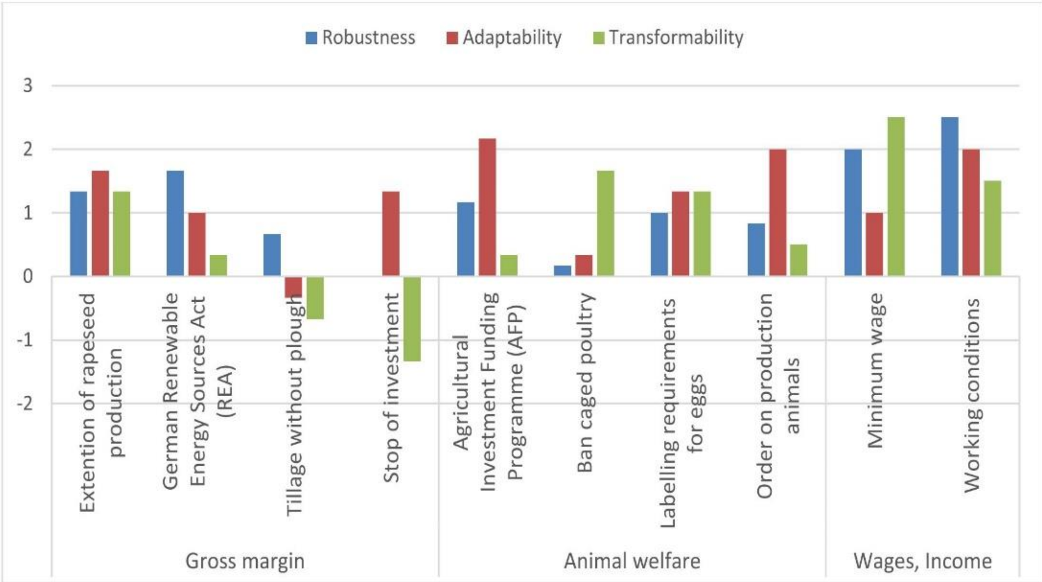


Figure 8.9. Bar graph showing average scoring of effect of strategy on robustness, adaptability and transformability of the farming system. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship.

Resilience attributes in relation to the capacities:

Participants allocated the highest contribution to resilience capacities to the attribute “socially self-organized”, followed by the attributes “supports rural life”, and “functional diversity”. All the three attributes contribute most to the robustness of the system and least to its transformability, which holds for all assessed attributes.

Robustness: Attributes which are considered to have the strongest effect on the robustness of the farming system are “socially self-organized”, “supports rural life”, “functional diversity”, “coupled with local and natural capital”, and “reasonably profitable”. For instance, “socially self-organized” connections increase the farming system’s immediate performance through opening-up alternative ways of exchange. Thereby, the attribute improves the marketing and purchasing performances within the system. The attribute “supports rural life” describes the important capacity to improve resilience through the improvement of rural living conditions which would make the region more attractive for potential employees and farm successors. The attribute “coupled with local and natural capital” characterizes the need in the Altmark to maintain natural resources due to the limited fertility of the sandy soil as well as its vulnerability towards erosion and drought. This, in turn, also fosters a “functional diversity” in such a way that the robustness of the farming system increases. The preservation of natural resources for example, an increase in functional diversity (ecological as well as economic functions) contributes to the stability of the system in times of weather shocks (e.g. through soil conserving farming practices as protection against erosion).

Adaptability: All the five attributes which are ranking highest for robustness also show among the best performances regarding the adaptability of the system indicating that while offering immediate response to shocks, they also foster changes in the system composition. This becomes particularly clear when looking at the attribute “socially self-organized”. Once new modes of interactions and links between stakeholders are established, new actors’ constellations in the system are likely to appear. In the same way, “functional diversity” is also an attribute that affects the system’s structural composition. While improved ecological practices can contribute to more stability towards extreme weather events, they mostly require some changes of operation on-farm. Simultaneously, are a sound ecological and economic functionality fosters the adaptability of the farm and the whole system, too. Functional diversity is estimated to contribute most to the adaptability while ranging in the middle when it comes to the assessment of transformability. “Diverse policies” range among the highest adaptability attributes as they set the legal framework for the future development opportunities of the farming system by providing new options as well as boundaries.

Transformability: For transformability, too, the attribute “diverse policies” is important and is considered to have the strongest effect on the capacity to transform the system. In general, the attributes’ contributions to transformability are seen to be much lower than to the other two capacities. “Supports rural life” and “Socially self-organized” which the workshop participants consider to be very important for robustness and adaptability are not estimated to be supportive enough to achieve a long-term transformability of the system and rate very low. Participants allocate the strongest ability to transform the system to institutional attributes such as policies, infrastructure innovation, and an improved coupling of legislation with local and natural capital.

The attribute “infrastructure of innovation” is equally contributing to robustness and transformation. In case innovation is accessible, the transformation of a farming system becomes possible. It can be considered as a prerequisite for a transformative process. A synergy is given because innovation can also lead to an investment into a more robust system. The same can be seen for the attribute “diverse policies”, which is scored by the participants to have influence on all capacities depending on the direction of the policy. According to the attributes, the farming system is perceived as robust and adaptable and less transformable. All the higher scoring attributes contribute most to the robustness of the system and least to the transformability.

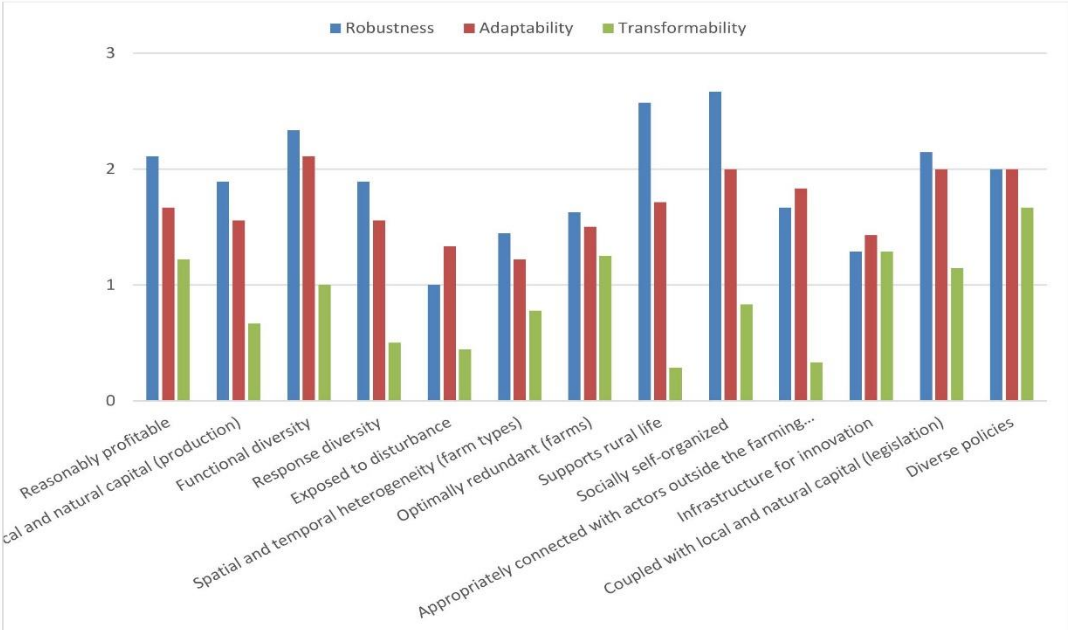


Figure 8.10. Bar graph showing average scoring of perceived effect of attribute on robustness, adaptability and transformability. A 0 implies no relationship, a 1 a weak relationship, a 2 a relationship of intermediate strength, and a 3 is a strong relationship.

The ResAT analysis (Figure 8.11) shows the following results[9]:

Robustness: The focus of ther German implementation of the CAP is on direct area payments. The direct payments provide buffer resources to stabilize incomes and thereby support the status quo. Therefore, the policy constellation strongly enhances the robustness of the farming system.

Adaptability: The ELER programming of the state Saxony Anhalt within the 2nd Pillar focusses on objectives which address challenges for the middle-long term such as protection of agricultural resources. But it suffers of the limited budget as only 4,5% of the 1st pillar budget ist transferred into the 2nd pillar. A key problem however seems to be that these measures are less adopted by the addressees as planned.

Transformability: There is little attention paid to long term issues and challenges and thereby for transformability. As there is no indication for a fundamental policy change after 2020, it can be questioned whether there is no long-term strategy or whether there is a consciousness of a political path dependency which is used strategically.

[9] Paragraphs copied from Daskiewicz and Balmann (2018): SURE-Farm T4.2: Assessing how policies enable or constrain the resilience of the arable farming in Saxony-Anhalt, Germany. An application of the Resilience Assessment Tool (ResAT).

The attributes are the key characteristics for resilience-enhancing policies displayed in the ResAT-wheel. The given colour (+ score) indicate to what extent the key characteristic is enhancing or constraining the resilience capacity.

Question: To what extent do the policy's goals and instruments enable or constrain the characteristic?		
Answers: enabling	**Answers: constraining**	**Score (+ colour)**
Not clear		**0** (White)
Not enabling	Very constraining	**1** (Red)
Slightly enabling	Constraining	**2** (Orange)
Fairly enabling	Fairly constraining	**3** (Yellow)
Enabling	Slightly constraining	**4** (Light green)
Very enabling	Not constraining	**5** (Dark green)

Figure 8.11. The ResAT wheel applied for the farming system in the Altmark.

8.6.3. Concluding remarks on resilience capacities

Currently, the farming system seems to perform best regarding adaptability and robustness. While the strategies are seen to mainly support the system to become more adaptive, its attributes are mainly considered to impact the robustness of the system. Nevertheless, they are perceived to have a moderate impact on adaptability, too. This trend, however, can be seen in the rating of the attributes. While self-relying attributes such as "socially self-organized" and "supports rural life" receive a strong affirmation regarding impact on robustness, stakeholders identify a greater need of appropriate institutional environments and supportive policies to encourage transformability (as for instance with diverse policies or infrastructure innovations).

Also at the farm level, adaptability has been rated as functioning well. But in contrast to the findings at the system level, farmers assess their own capacities to transform better and their robustness to immediate shocks lowest. This somehow reflects that farmers in the Altmark are business oriented. Shocks can always challenge them but they plan towards their future – maybe more than other actors in the system do.

8.7. RESILIENCE ATTRIBUTES

8.7.1. Farmers and farm households

The learning interviews revealed a double function of learning: it enhances farmers' and their households' resilience both directly and indirectly. On the one hand, learning potentially directly contributes to resilience by learning from others, acquiring information, implementing best practices from colleagues or cooperating with other farmers (experimenting, sharing inputs). On the other hand, learning strategies (e.g. experimentation, learning from others, acquiring new information, and reflexivity) enabled farmers to adopt better risk management strategies and therefore indirectly enhances resilience, too. Accordingly, farmers of the Altmark perceive a good integration into social networks. In the farmer survey, all farmer groups rated their integration into networks high, with farmers belonging to the group "others" showing highest score. Furthermore, all farmer groups strongly agree with knowing many others farmers in the region but estimate the existing support between farmers in the region in case of problems lower than all other network items. Similarly, while all farmer groups indicate to know many agricultural professionals and experts in the value chain, they have a lower perception of the possibility to receive support from these and other actors in their network. These findings indicate a structural problem of lacking institutionalization of support platforms which constraints the tightness of feedback. In case of challenges, the network does not necessarily help the farmers to overcome their problems. However, the support items in the survey still receive medium agreements also showing that existing networks do to some extend contribute to the resilience of the farms.

Due to sandy and clay rich soils, farming is less intense in the Altmark. The poor soil quality constraints the farms' resilience because it limits the yields and therefore farms' profitability. However, while the possibilities in arable farming activities are limited, in some cases it has motivated farmers to diversify into other segments such as dairy production (high share of grassland). Such a functional diversity increases resilience of farms since it provides backups in case of seasonal failures of one production strand. Farmers also show response diversity regarding their implementation of past risk management strategies. Important past risk management strategies that have been mentioned in the farm survey include farm diversification, investment in new technologies, new marketing strategies or the improvement of value chain cooperation. The openness of farmers towards new approaches becomes apparent but of course, some farmers tend to be rather resistant to change. Nevertheless, farmers and their households' openness is constrained by only receiving very few incentives from other systems nearby because of the marginalized status (low infrastructure) of the region. For instance, off-farm jobs are lacking and cultural/social offers are scarce and distant. This, in turn, also constraints the system reserves. The region of the Altmark is little attractive and farm successors or motivated, well-trained workers are not easy to attract. This difficulty might hamper the willingness to invest into the farm. Social capital is further affected by the negative reputation of (mainly conventional) agriculture and the corresponding social pressures on farmers. System reserve capitals are generally perceived as low in the Altmark and put more pressures on farmers. Institutional capital is experienced rather low. Famers perceived that strict regulations and bureaucracy constrain their resilience and ability to try out new things. The increase in extreme weather conditions affects the system reserves (next to ecological possibly also social and economic capitals). These uncertainties contribute to the psychological pressure that farmers mentioned in interviews. Since farming's profitability is rather low, minor economic capital reserves, too, are rather constraining resilience.

8.7.2. Farming system

According the participants of the FoPIA-SURE-Farm workshop, all attributes perform in a (very) small to moderate extent in the Altmark. The higher performing attribute "socially self-organized" in the Altmark region is defining the system with the principle of modularity, since a bypass of socially self-organization is used to increase the performance. The system is using additional, alternative ways of connections for the purpose of marketing and purchasing to increase the modularity of the systems components. This increases the resilience. The two attributes "spatial and temporal heterogeneity" and "response diversity" are performing moderately. They are related to the principle of diversity which is enhancing resilience performance. A diverse production system increases the resilience because of distribution of the income in case of failure of one component. In the Altmark, the farms are mostly quite diverse in their production because of the low soil quality, unfavorable climate conditions and rural structures. Another higher performing attribute is "coupled with local and natural capital (production)". It is a characteristic to strengthening the principle of system reserves. The resources have to be maintained in the region due to poor soil fertility and unfavorable weather patterns. Farmers in the Altmark have to handle the limited productivity of the land and therefore apply rather extensive agriculture practices. Because of these conditions, the farms developed a "response diversity" to adjust to and gain diversity in the management. However, profitability is estimated low and, together with the very low scoring attribute "coupled with local and natural capital (legislation)" indicates a low performance of institutional system reserves. These limited economic reserves for human capital also restrain the system's opportunities for transformation. In order to improve working conditions, automation and new technologies were implemented in the past in the farming system of the Altmark region, represented in the moderately scoring attribute "infrastructure for innovation" and also indicating a moderate level of openness in the system. This increased the productivity mostly in the dairy sector and contributed to the robustness of the system. However, in order to transform the system, investment in infrastructure is needed to gain better access to more innovations, which enables transformation[10]. Since this policy support is currently missing, the tightness of feedback in the system is rather low.

[10] This paragraph is based on FoPIA-SURE-Farm Case-study Report Germany.

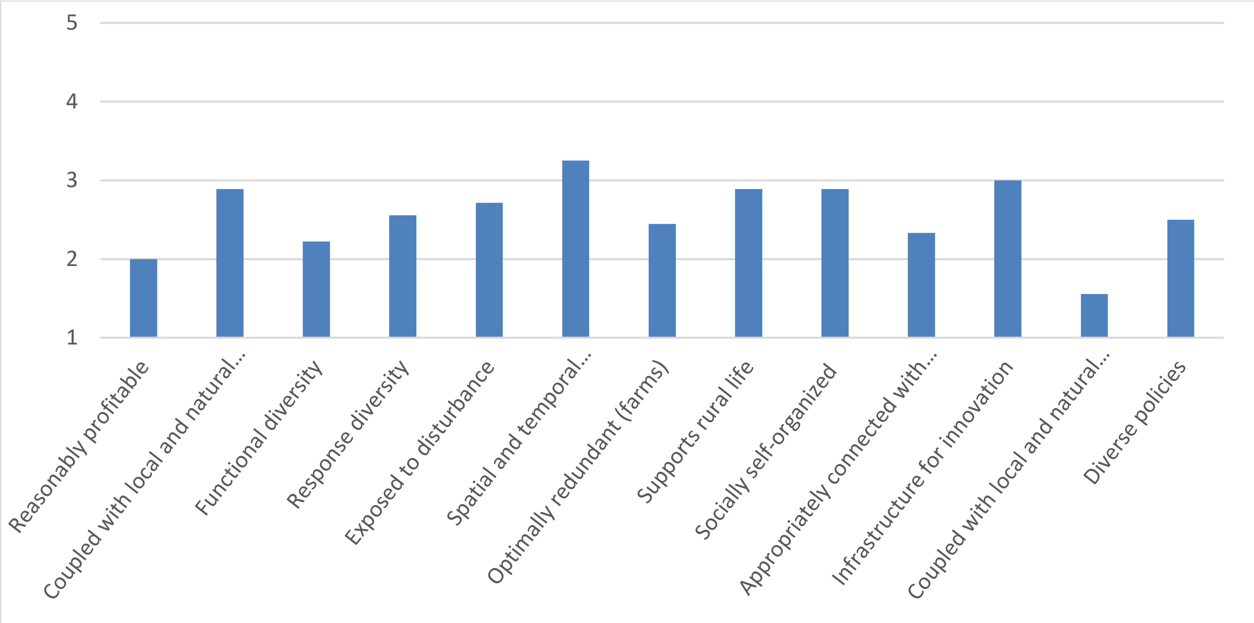


Figure 8.12. Bar graph showing current performance level of resilience attributes. Performance is scored as 1 = not at all, 2 = small extent, 3 = moderate extent, 4 = big extent, 5 = very big extent.

8.7.3. Concluding remarks on attributes

At the system level of the Altmark, the attributes are perceived to perform relatively low to moderate, but are still perceived to be able to shape the resilience processes (farm demographics, agricultural practices, risk management and governance). One important finding is that the contributing attributes are mainly perceived to be performed by farmers and other private actors (civil society, value chain actors), while a lack of support from the public sector is sensed. For instance, while farmers' self-organization helps to build up new resilience enhancing governmental structures, there is a lack of institutionalized supporting platforms for long-term learning and exchanges. Hence, there is room to increase public activities to create an enabling environment. At this stage, the findings indicate that resilience attributes perform better at the farm level than at the system level. Nevertheless, at this level, too, there is much room for improvement, particularly regarding system reserves, which, however, are mainly beyond the control of the farmers alone.

The attribute "socially-self organized" contributes to the process governance. By building their own networks and institutions, the stakeholders in the case study initiate new opportunities to govern the system e.g. through new selling options by skipping one or multiple actors. The attribute "coupled with local and natural capital (production)", contributes to the process of agricultural production. Like mentioned above, the agricultural system is faced by limited resources and therefore has implemented specific agricultural production practices to produce in the longer term. The attributes "response diversity" and "spatial and temporal heterogeneity (farm type)" contribute to the process of risk management. Risks which are mostly managed with this attribute in the Altmark are short-term environmental and economic risks (e.g. weather extremes and fluctuating market prices).[11]

Table 8.2. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance). The table continues over two pages.

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Heterogeneity of farm types		Multifunctional farming (AP, RM) Good functional diversity (AP) Good response diversity (RM)	
Openness		Lack of policy instruments dismantling status quo (G) Marginalized status of the region leads to little inputs/incentives from other systems (e.g. due to lack of off-farm jobs and cultural/social offers) (G, FD)	Open-minded to change (RM) Investment in new technologies Open towards new forms of farm succession (e.g. share cropping arrangements)	Resistance to change (RM)
Tightness of feedbacks	Moderate to good level of self-organization (G)	No full translation of networks into long-term learning, missing of institutionalization of support platforms (G) Rigid bureaucracy and strict regulations hamper innovations (G)	Engaged in networks, exploring collaboration (G, RM)	Knowing agric. professionals does not necessarily imply support by them (G)
System reserves	Policy instruments on buffer resources and risk management (RM),	Relatively low profitability hampers transformability (AP), Legislation is hardly coupled with local and natural capital (G)	Alternative forms of farm succession (FD)	Feelings of shame and frustration Multiple pressures (social, psychological, financial)

[11] Paragraph is based on FoPIA-SURE-Farm Case-study Report Germany.

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
	Moderate level of infrastructure for innovation (AP, G) Production is well coupled with local and natural capital (sustainable production due to limited resources) (AP)	Low economic, ecological, social, and institutional capitals in the region (G, FD)		
Modularity	Additional, alternative ways of connections for the purpose of marketing and purchasing to increase the modularity of the systems components (G).	Lack of policy instruments on in-depth learning (G)	Reflexivity, experimenting (AP, RM)	

8.8. ADAPTIVE CYCLE

After the German reunion in 1990, the farming system of the Altmark collapsed and had to be reorganized completely. Until then, the prevailing organizational form of agriculture were agricultural production cooperatives (Landwirtschaftliche Produktionsgenossenschaften, LPG), where almost all farmers were urged/forced to enter and to contribute their lands. Hence, the farmers became workers of the LPGs while holding their respective shares of it. After the collapse, most of the LPGs terminated. Given the structure of large merged plots, in a complex process of redistribution, many of the LPGs were converted into large corporate farms. After the collapse, farmers in the Altmark managed to reorganize themselves and the system achieved consolidation. It is difficult to classify the process as effectively getting into a conservation phase since some elements appear to be in a permanent process of adaptation, almost never achieving a sound stability. While farms developed a lot over the past and growth occurred regarding agricultural production, many farms still operate at their existence minimum. Besides, livestock has decreased and numbers of farm workers reduced. Regarding the separate processes, they all have room to achieve a sound conservation phase, except *farm demographics.* The latter is already heading towards the next collapse, because of the above described problems of farm succession and labor shortages. For the three remaining processes, there is still considerable potential for growth, what holds particularly for *governance* and *risk management* processes. The room for growth for agricultural production is less, because the farms are already close to the limit of their productive capacities and restrained by the given natural factors and the institutional deficiencies which affect the farming system in the region. The shortcomings of governance approaches and their failure to appropriately reply to local needs and to support the system in its transformation efforts have been described above. Particularly the rigidity of bureaucracy hampers the development and implementation of innovative risk management strategies. Furthermore, the introduction of long-term and stable policies would encourage transformative actions which can avoid the collapse of the system.

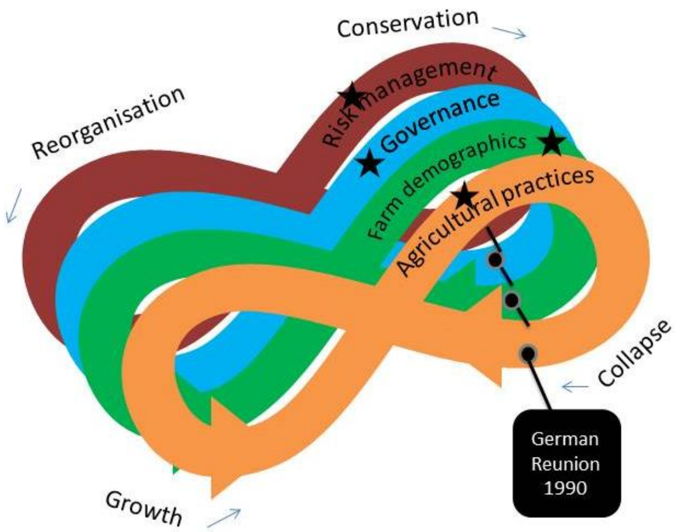


Figure 8.13. Positioning the German farming system on the adaptive cycle of processes in agriculture.

8.9. STRATEGIES

Strategies for the future should target aspects of robustness, adaptability and transformability in order to increase its overall resilience. However, the focus should be on a participatory design of strategies which allows the system to sustainably cope with major future challenges, as for instance climate change, increased global competition, and an aging society. Table 8.3. summarizes future strategies mentioned per process.

Table 8.3. Future strategies per process.

	Future strategies
Agricultural production	- New technologies (new drought resistant varieties; precision agriculture, more efficient irrigation schemes) - Adapted tillage, soil protection measures, humus reproduction - Improve alignment of products with the market demand instead of continuing producing what one used to always produce just because traditionally it has been always produced
Farm demographics	- Invest in training and education of potential workers - Improvement of working conditions

	- Focus on engagement in partnerships with colleagues and institutions in the region (schools) - Create platforms of best-practice sharing regarding succession and training activities
Governance	- Increase continuity and transparency of regulations - Decrease the rigidity of legislations and bureaucracy which are seen to need to become more flexible and adaptive - Support succession processes - Overcome marginalization of the Altmark: improve overall infrastructure - Financial support for irrigation technologies and innovation
Risk management	- Takeover or farm the land of closed / passive farms - Smaller farms: direct marketing (limited due to low purchasing power in the region - Find ways of investment in technologies, e.g. through machinery sharing rings - Improve cooperation (value chain actors: purchase and marketing; farmers, experts, and institutions: information flow, development of programs, implementation of innovations; farmers and civil society: climate change adaptation and mitigation, exchange on future visions on farming system) - Prepare for climate change adaptation - Improve information flow between institutions and farmers

8.10. CONCLUSION

The farming system in the Altmark is currently mainly characterized by the “exploitation and conservation” phase of the adaptive cycle. The gross margins of farms are very low. Hence, strategies in the past aimed to increase their profitability (e.g. through extension of biogas production) and quality standards (e.g. through diverse policies) and are characterizing the exploitation stage in the adaptive cycle. Natural capital is conserved because of the extensive type of farming. This, however, is rather an effect of the natural limitation stemming from the poor soils in the region and represents farmers’ capacities to adapt their production to the natural capital. In their attempts to become economically more viable, many farms pursue diversification strategies. Stakeholders reported to face difficulties in the implementation of innovations due to the rigidity of bureaucracy. Yet, the diversity of the production system combined with the extensive management is characterizing the system as adaptive, in the resilient rational according to Hoekstra et al. (2018). However, the human capital is limited because the farming system is not sustainable in terms of profitability and consequently cannot pay decent wages to agricultural workers. In addition to this, taking up an employment in the agricultural sector of the Altmark is very little attractive due to the structural marginalization of the region regarding infrastructures, as for instance, social and cultural opportunities, good internet or transport connections to the next metropoles. These attributes pose a challenge, particularly when it comes to farm succession or hiring skilled labor. Therefore, the farming system is mainly adaptable and also robust in particular processes but experiences a lock-in due to low wages and infrastructure issues. Consequently, transformability of the farming system is considered to be low.

9 CASE STUDY BULGARIA

Mariya Peneva, Stela Valchovska

9.1 ABSTRACT

The aim of the report is to summarize and synthesize the results and analyses in the framework of SURE-Farm project concerning resilience of specialized arable/crop farming system (based on the large-scale grain production) in North-East region as a case study in Bulgaria (Figure 9.1).

Utilized approach is based on SURE-Farm methodology (Meuwissen et al., 2019) and consequently deals with the following issues: definition of the farming system, outlining the challenges and opportunities it faces, evaluation of essential functions delivered by the farming system, resilience capacities and attributes via a series of interviews, workshops, focus groups and surveys conducted with a range of stakeholders from the farming system. Furthermore, the current stage in the adaptive cycle for the grain farming system in North-East Bulgaria is presented based on the past developments, present situation and the future expectations concerning the processes of risk management, governance, demographics and agricultural production.

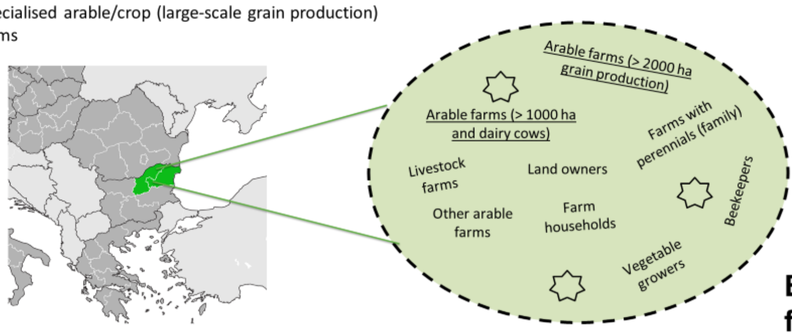
The analyzed farming system consists mainly of the large-scale grain producers (both corporate and family) in the North-East region of Bulgaria (North-Central (BG32) and North-East (BG33) statistical NUTS 2 regions) and the other actors as land owners, farm households and neighbors with different specialization which affect and are affected by the grain farms. The challenges which the system faces include: constantly changing policies and legal framework, fragmented land ownership and their regulations, price volatility, climate changes and depopulation of rural areas. The studied grain farming system performs better in provision of private goods (food production and economic viability) than in provision of public goods (biodiversity and habitat) and there is a significant room for improvement in its performance.

The general resilience of the system is assessed to be medium to low, considering the attributes performance. The grain farming system operating under the current circumstances shows relatively high capacity to keep status quo and proved to be at a relatively low level of transformation. But the farmers understand the need to adapt their decisions according to the new realities and demonstrate adaptability in their efforts to overcome challenges, like lack of labor force and climate changes, implementing new technologies and varieties, and looking for local decisions and adaptations of the innovative approaches towards the production process, technology and land management.

Farming system

North-East Bulgaria (BG)

Specialised arable/crop (large-scale grain production) farms



Farm — Main farms in analysis

Actors — Other FS actors

Locality (agro-ecological context, infrastructure, public goods, identity, ..)

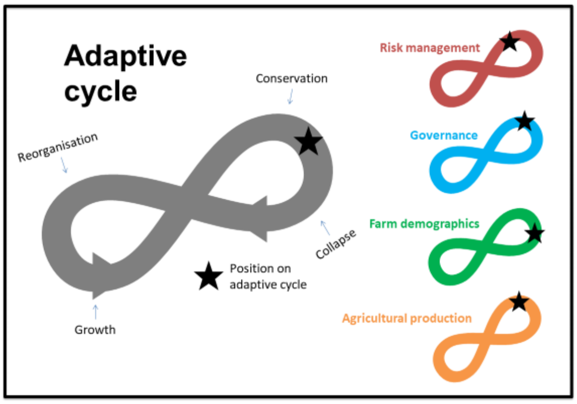
Challenges

Institutional:
- Constantly changing policies and regulations;
- Land ownership and their regulations;

Environmental:
- Climate change;
- Soil fertility;

Economic:
- Price volatility;
- Limited use of insurance;

Social:
- Depopulation, ageing;
- Changing consumers' preferences;
- Society expectations;



Essential functions

Private goods:
- Food production: *good performance*
- Economic viability: *medium performance*

Public goods:
- Quality of life & Attractiveness of the area: *medium performance*

Need more attention: functions related with environment and nature

! Biodiversity and habitat: *low performance*
Animal health and welfare: *low performance*

Resilience capacities

Current policy configurations foster robustness and neglect transformability;

Adaptability receives stronger support through policy goals rather than policy instruments;

Relatively high capacity to keep status quo; relatively low capacity to transform;

Farms demonstrate adaptability, in general

Resilience attributes

Diversity: moderate to high	Fertile soils and good conditions for arable farming in general Limited by the lack of irrigation infrastructure
Modularity: low	Polarized farms' structure
System reserves: moderate	Production is coupled with natural capital but it is limited by the social capital due to the depopulation and ageing processes in the region
Tightness of feedbacks: low to moderate	Lack of policy support instruments dismantling status quo; Mutual dependence between farmers and land owners and high level of competition for main production factor: land (enhancing for robustness; constraining for adaptability and transformability)
Openness: low	Learning capacity and awareness about its importance Low level of connectedness with the scientific and educational institutions

Future strategies

Risk management
- Optimization of production costs and securing proper assets to decrease external dependencies
- Exchange of information about farming and risks through participation in fairs (incl. international), exhibitions and trainings

Governance
- More stable policies with long-term vision
- Improve societal appreciation
- Infrastructure improvements to attract young generation to live in rural areas

Farm demographics
- Stimulating succession
- Reflexivity, open-minded, self-criticism, appreciate farm workers
- Better cooperation with research institutions and universities

Agricultural production
- New crops
- New technologies
- Experiments to adapt new varieties to local conditions
- Diversification: crops; mixed farming, territorial diversity of plots & non-farm activities
- Improved soil management

This project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 727520

University of National and World Economy, Sofia, 1920

Figure 9.2. Factsheet synthesizing current resilience of the horticulture faming system in North-East Region, Bulgaria.

9.2 FARMING SYSTEM

The Bulgarian case study considers the grain farming system in the North-East region of the country. It includes the North-Central (BG32) and North-East (BG33) statistical regions at the NUTS 2 level (Figure 9.2).

At the NUTS 3 level (districts), they include the regions of: Veliko Tarnovo (BG321); Ruse (BG323); Razgrad (BG324); Silistra (BG325); Varna (BG331); Dobrich (BG332); Shumen (BG333); Targovishte; (BG334) and Gabrovo (BG322).

Figure 9.3. Geographic location of North-East Region, Bulgaria

Research through the surveys, interviews and workshops has considered all of these regions as potential sources for research participants. Gabrovo is the only district where interviews were not taken due to the very low number of large scale crop producers, as a result of the local production conditions. The ecosystem services assessment has a smaller target area for analysis, including: 12 cells in the center of BG321; 6 cells in the center and on the east of BG33; 8 cells on a cross border between BG334, BG333 and BG324; 2 cells in the center of BG333 and 1 cell on the south of BG324.

Main farm type in the case study are large-scale (above 1000 ha of arable land) mechanized farms, specialized in the production of grains, maize and sunflower. Large-scale grain farming has been distinctively present in this part of the country since more than a century. Nevertheless, it exists since about 30 years in its current form, developed gradually after the transition towards a market economy during the 90ties of 20th century.

FoPIA-SURE-Farm stakeholder input to the farming system diagram in Figure 9.3 emphasized the role of additional farm types, like beekeepers and vegetable growers, as impacting on the activities of grain famers. It also revealed that international markets of commodities had stronger impact on their decision-making than initially assumed by the researchers.

Stakeholders from the AgriPoliS focus group workshop revealed that grain farmers are strongly dependent on subsidies for their existence. They rely heavily on unskilled labor for work on the farms. Where skilled labor is needed, the grain farmers engage with the training of the labor force. Family members also contribute to skilled and decision-making roles as well as succession. In terms of labor, the farming system is strongly dependent on the local population. Respectively, the challenges related to the people in the regions, like depopulation or low incomes, have strong effects on the faming system through the availability of human resources.

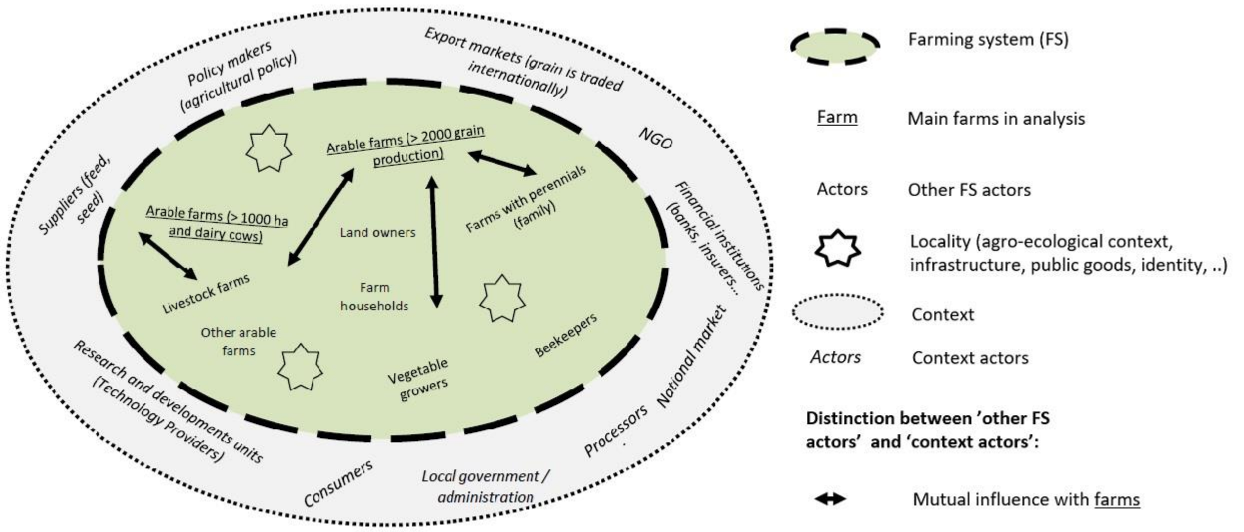


Figure 9.3. Revised farming system visualization after feedback from participants during FoPIA-SURE-Farm workshop 1.

9.3 CHALLENGES

9.3.1 Overview of identified challenges

Table 9.1 synthesizes the challenges identified across methods. A synthesis at farm and farming system level is provided in the next sections.

Table 9.1. Summary of challenges across methods. The table continues over three pages.

			Environmental	Economic	Social	Institutional
Farmers	Ranking based on farm survey	Grain farms	1 (most relevant)	2	4 (least relevant)	3
	Shocks	Learning interviews	Floods; Droughts; Disease outbreaks;	Price volatility; International politics;		
		Demographic interviews		International competition;		
		AgriPoliS focus group				
	Long-term stresses	Learning interviews	Preservation of soil fertility; Bad weather; Climate change; Pests and diseases;	Capital intensive – requires machines; Innovations not adapted to local conditions; International competition;	Neighboring farmers; Depopulation and standard of living in rural areas;	Policy continuation and changes; Relationships with institutional bodies; Co-operation with other farmers

			Environmental	Economic	Social	Institutional
				Quality and quantity of available labor;		
		Demographic interviews	Natural conditions; Climate change; Pests and diseases;	Proper technology implementation; Importance of insurance not recognized; Competitors' development;	Relationships with colleagues and the local community; Impact of the successful farm business on the community;	Greening and ecological requirements; Territorial allocation of the farmed plots;
		AgriPoliS focus group				
Households	Shocks	Demographic interviews				
	Long-term stresses	Demographic interviews			Changing needs and expectations of society;	
Farming system	Shocks	Focus group RM				
		AgriPoliS focus group				
		ResAT	Extreme weather events	Rises in input prices (i.e. fuel)		
	Long-term stresses	Focus group RM	Droughts; climate conditions;	market uncertainty; farm investment; competition; innovation;	Depopulation; Low motivation and payment for farm labour; Lack of skills;	Low institutional support; Administrative issues;
		AgriPoliS focus group		Low motivation and payment for farm labour; Lack of skills;	Depopulation; Disconnection from farming;	Increasing requirements; Decreasing subsidy support; Low institutional support;
		ResAT	Climate changes Monoculture farming and high level of inputs Underground water and air contamination Water supply and irrigation	Price volatility; Changing level of subsidies; Output markets; Low use of insurance; Low capacity for financial management	Depopulation; Population ageing (lack of skilled labour force both for field work and managerial staff) Lower level of income	Land relations; Weak institutions;

			Environmental	Economic	Social	Institutional
			Practices related to policy greening		Changing needs and expectations of consumers and the society;	
Farming system (past challenges)	Shocks	FoPIA-SURE-Farm	Extreme weather events; Agri-ecological requirements;	Price volatility; Decreasing subsidy support; Limited use of insurance;	Lower standard of living in rural areas; Changing needs and expectations of consumers and the society;	Land relations; Weak institutions; International environment;
	Long-term stresses	FoPIA-SURE-Farm	Climate changes Monoculture farming and high level of inputs Underground water and air contamination Limited opportunities for irrigation;	Output markets; Low capacity for financial management;	Depopulation; Population ageing (lack of skilled labor force both for field work and managerial staff)	

9.3.2 Present challenges for farmers and farm households

According to the respondents' perceptions expressed in the farm survey, in the next 20 years, the main challenges are: 1 Persistent extreme weather events (e.g. floods, droughts, frost); 2 Pest, weed, or disease outbreaks; and 3 Low soil fertility (Figure 9.4).

In terms of the four main categories of challenges, grain farmers score environmental challenges the highest (5.84 on average), followed by economic challenges (4.31 on average), followed by institutional (3.98) and social (3.77) challenges.

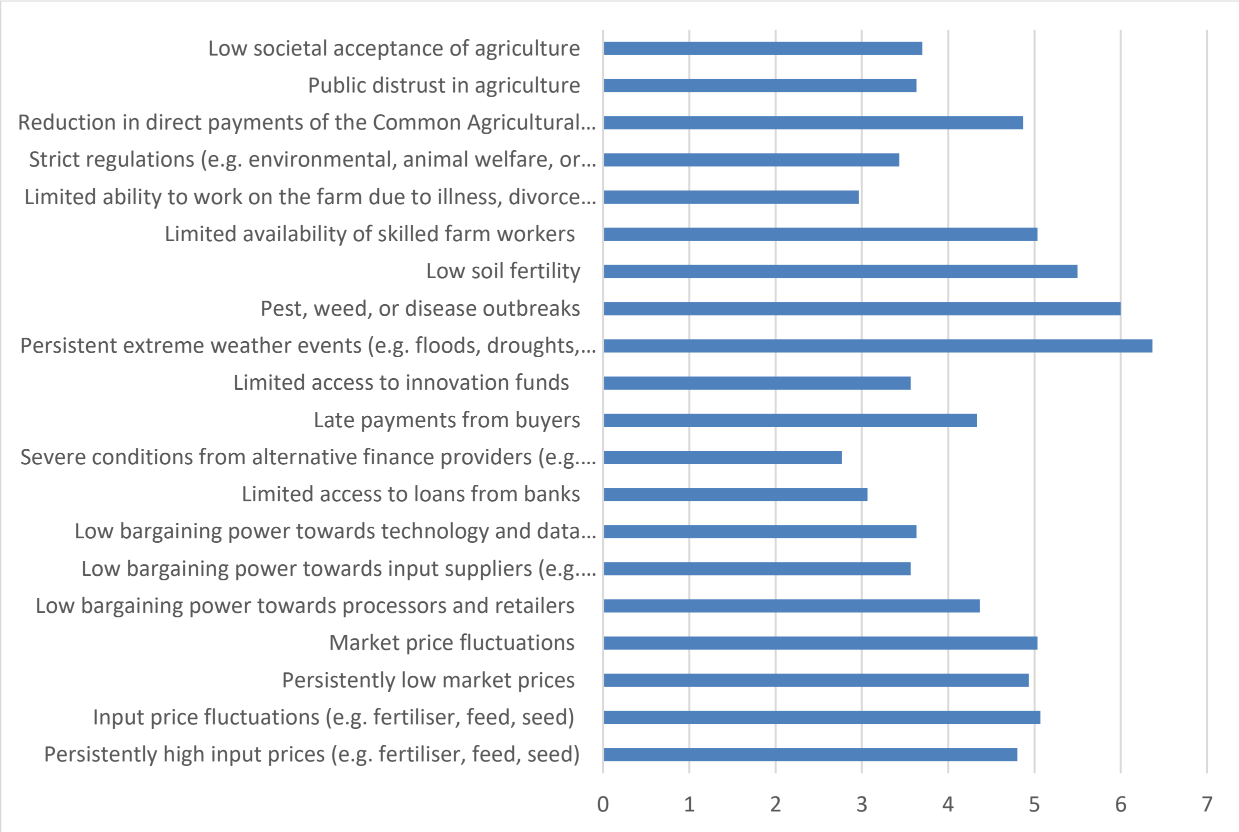


Figure 9.4. Perceived relevance of challenges (Source: Spiegel et al., 2019), 1 (not challenging at all for my farm) to 7 (very challenging for my farm) .

The interview-based tools reveal results that are in line with the farm survey with respect to environmental challenges. Both learning interviews and demographic interviews highlight the condition of natural resources and the occurrence of pests and diseases as long-term environmental concerns of grain farmers. Bad weather, as represented by floods and droughts affecting the crops, appear as a long-term challenge as well as a shock. All of these factors affect output and profitability directly.

Several economic challenges have been identified by grain farmers during the two interview-based studies. International competition emerges from both and is recognized as both a long-term and a shock challenge. It directly affects the grain output prices and, respectively, profitability.

In view of the significant role of environmental challenges, insurance is not recognized as a way to minimize the negative consequences from them. This has been revealed through the demographic interviews. The learning interviews highlighted that the need for a high level of mechanization in the grain farms creates pressure for finding investment capital in the long term. This can be a limitation for the development of the farm businesses.

Human resources are a long-term economic challenge with a two-fold role. On the one hand, they are related to the available quality and quantity of farm labor that helps maintaining the farm operations in time. On the other hand, they affect the possibilities for implementation of new technologies. According to the grain farmers, available labor may not be able to work with some new technologies, even after appropriate training, and this hinders their business development. Another long-term economic challenge was revealed with respect to the appropriateness of innovations to the local condition. Many of the offered new technologies are launched by international companies and need to be tested and adapted to the specificities in the region.

As economic shocks with short-term impact have been recognized volatile prices and political trends. Farmers link price volatility to the need of knowledge and experience with international markets as well as the common understanding about how those markets are functioning. They also recognize political trends, like the Russian embargo, and more general political risks originating from global conflicts between countries and blocks.

Some of the social challenges are of more general nature and their emergence through the two interview studies suggests that grain farmers recognize pending pressures from the wider social context. Learning interviews point to the rural depopulation and overall adverse living conditions – low level of main infrastructure and services, etc. The demographic interviews reveal that grain farmers are aware of the changing needs and expectations of society. These are associated with more care for the natural resources used by grain farmers and provision of safe and healthy food.

Other long-term social challenges are more specifically related to the farming activity. These include the interaction with neighboring farmers during the production process, mentioned in the learning interviews. The grain farmers highlight that when working with biological organisms and for some natural processes, there are no borders. This means that grain farmers cannot operate in isolation and their production results can be affected by the actions of neighboring farmers.

Social connectedness to members of the local community represents a long-term challenge according to the demographic interviews. Grain farmers emphasize the importance of participation in social activities and relationships. They also highlight the importance of their achievements being related to the local community. This helps developing stronger attachment to the place and extends the meaning of the farming business.

Learning interviews and demographic interviews overlap in identifying institutional long-term challenges related to the greening of the policy and the regulation of land relations. Greening the CAP is related with additional ecological requirements for the grain farmers. Nevertheless, they agree on the need for changes towards more environmentally friendly practices. They also argue that the CAP greening should be implemented in a different way due to the negative impacts of the current farming system – increased level of diseases and the need to increase chemical inputs.

Another very important issue related to the institutional arrangements which challenges farmers is the land relationships. These relationships are very much complicated both by the existing structure of fragmented land ownership as a consequence of privatization process after the collapse of communist regime and the changeable legislation. The negative effect is on the land market as the level of land prices (including rents/leases) has increased enormously and farmers' expenditures as well. These relations also affect the territorial allocation of the farmed plots, where solutions do not always achieve fairness and efficiency.

In addition, the learning interviews reveal institutional challenges related to: lack of long-term stable decisions (frequent legislative changes); lack of national strategy in agriculture and subordinated implementation of the CAP according to national priorities and specificities; low level of cooperation with colleagues; low level of trust in institutions (low administrative capacity) and policy makers; bureaucracy and administrative hindrances; lack of coordination between different institutions.

9.3.3 Present and past challenges for the farming system

Studies with specific focus on the farming system contain opinions of other stakeholders in addition to grain farmers and provide consistent results with the interview-based studies. The two focus group studies do not focus extensively on the different categories of challenges and provide only partial results. Available results reveal only long-term challenges. The focus group on risk management highlights severe weather conditions, as represented by droughts, and climate conditions in general as long-term environmental challenges. The AgriPoliS focus group topic was related to labor force and environmental challenges were not discussed.

Economic challenges brought forward included market uncertainty, farm investment, competition, innovation, and human resources deficiencies, which have also been identified through the interview research. The AgriPoliS focus group highlighted existing outflow of labor from agriculture. In addition, the skills of available labor are insufficient for filling the required positions without further training.

The social challenges identified through the focus group on risk management linked human resources with the social context of the case study. They emphasized the depopulation of the regions and the lack of attractiveness of farming as a source of employment as reasons for the human resource challenge. The AgriPoliS focus group highlighted the lack of a working system that facilitates education in agriculture and the acquisition of relevant skills (to increase the supply of skilled labor).

Both focus groups studies identified institutional challenges in relation to the provision of labor force, although in the AgriPoliS focus group these have been reported as social challenges. The AgriPoliS focus group also identified increased requirements, decreasing subsidy support and overall low institutional support to grain farming. These are in line with the interview research.

Challenges, mostly in the form of shocks, have been identified through the reports of stakeholders during the FoPIA-SURE-Farm workshop. They were compared with available secondary data for triangulation. Long-term challenges have been identified during earlier stages of the research project for use in the resilience assessment tool (ResAT). They have been identified through expert interviews as well as academic and grey literature review prior to the document analysis. The ResAT challenges have not been divided into shock and long-term during the analysis. FoPIA-SURE-Farm takes a historical view of the challenges to the farming system. Findings from both studies are consistent with the other research methods.

Economic shocks are represented by price unpredictability and the rises in input prices. They represent challenges for farmers both in the past and the present. In addition, FoPIA-SURE-Farm revealed decreasing subsidy support and limited use of insurance as economic shocks. This result is an example of overlap between categories of challenges. Subsidies have an institutional origin, but stakeholders highlight their economic impact on the farms. Some of the economic shocks are occurring regularly and this allows to analyze them as long-term economic challenges as well.

Environmental challenges offer more examples of the relevance of challenges for different categories. Increased requirements as a result of greening of the agricultural policy are perceived as environmental shocks. This perspective is possible if some farmers have not considered certain agri-environmental practices before they became a compulsory condition for receiving subsidies.

The social and institutional challenges, discussed in ResAT and FoPIA-SURE-Farm, do not offer any additional insight to the other methods. There are some differences in the classification of challenges in the categories. They are due to dividing the challenges into permanent and non-permanent for the purposes of FoPIA-SURE-Farm. 'Permanent' does not completely overlap with 'long-term', and 'non-permanent' does not completely overlap with 'shocks'.

The differences can also be attributed to difference in the methodologies of the two studies. In the document analysis, the challenges were used as predefined notions and did not change throughout. Discussing them with stakeholders during the FoPIA-SURE-Farm workshop, allowed to bring in the perspective of the stakeholders and could change the initial view on the role of certain challenge.

9.4 OPPORTUNITIES

9.4.1 Present opportunities for the farming system

Insights into different opportunities for the grain farming system in the North-East Bulgaria were provided in the learning and demographic interviews. For long-term economic opportunities for the farming system as a whole, farmers see that farming of the current size and specialization is mainstreamed as a profitable business. Thus, the economic viability is one of the opportunities and circumstances enabling farm success in several cases. Another important factor identified which exaggerated the perception for increased opportunities in agriculture is the CAP implementation in Bulgaria, because financing the business is crucial to continue.

Other influential factors identified as precondition for the existence and development of the current farming system creating opportunities is the experience and knowledge farmers had. Most of them claimed that their interest in farming is from the childhood when they were used to help in the family farms. Their memories as well as the feeling to be proud of his/her realization stimulated them to achieve what they have as a business. And this experience and feeling they try to transfer to the next generation and many of them advice their children to acquire education and training in agriculture. Interviews revealed the importance of education and training (even abroad) of the next generation combined with open-minded to new ideas and technologies, and innovations in general, for finding new opportunities for business developments.

9.4.2 Past opportunities for the farming system

Historical developments in Bulgaria laid down different circumstances for farming system as a private activity, stimulating entrepreneurship and competitiveness of the farm structures. Thus, twenty years ago the different market opportunities were pointed out as reasons to enter farming after the collapse of communist regime. A summary of these developments are the four main strategies identified under the FoPIA-SURE-Farm workshop. These strategies fully encompass the actions undertaken during the studied period (2000-2018), which led to substantial changes into the farm developments and to the current situation in the region. Each strategy relates to several different challenges and at the same time reflects the opportunities which farmers had to enter and continue farming activities. The most important ones are the possibility to increase the farmed land gradually and the application of good farming practices as part of the current introduction of agri-environmental requirements, but as well as opportunity to increase farm resilience.

9.5 FUNCTIONS

Functions were discussed and assessed in detail only in the FoPIA-SURE-Farm workshop. In all the other methods, different functions emerged as important for the farmers and/or other stakeholders and they elaborated on this importance. But no unified scoring system as in the FoPIA-SURE-Farm workshop were used, where both groups of functions – private and public – have received scores of 3 (moderate) to 5 (very well). The stakeholders prioritized the delivery of private over public goods.

In addition to the stakeholder perspectives, a quantitative assessment of the current state of the ES considers the provision of public and private goods in a selected part of the region. This assessment uses publicly available datasets to estimate the delivery of public and private goods provided by the grain farming system in North-East Bulgaria.

9.5.1 Farmers and farm households

According to the farm survey, 'Farm income' is considered as the most important function, followed by the 'Provide employment and good working conditions for my employees' and the 'Delivery of quality food products' (Figure 9.5).

The higher importance placed on private goods emerges through the two interview studies as well. In addition to income, grain farmers value and take pride in the achieved high levels of productivity. The interviews showed that public goods are dominated by concerns for the natural resources used in grain farming.

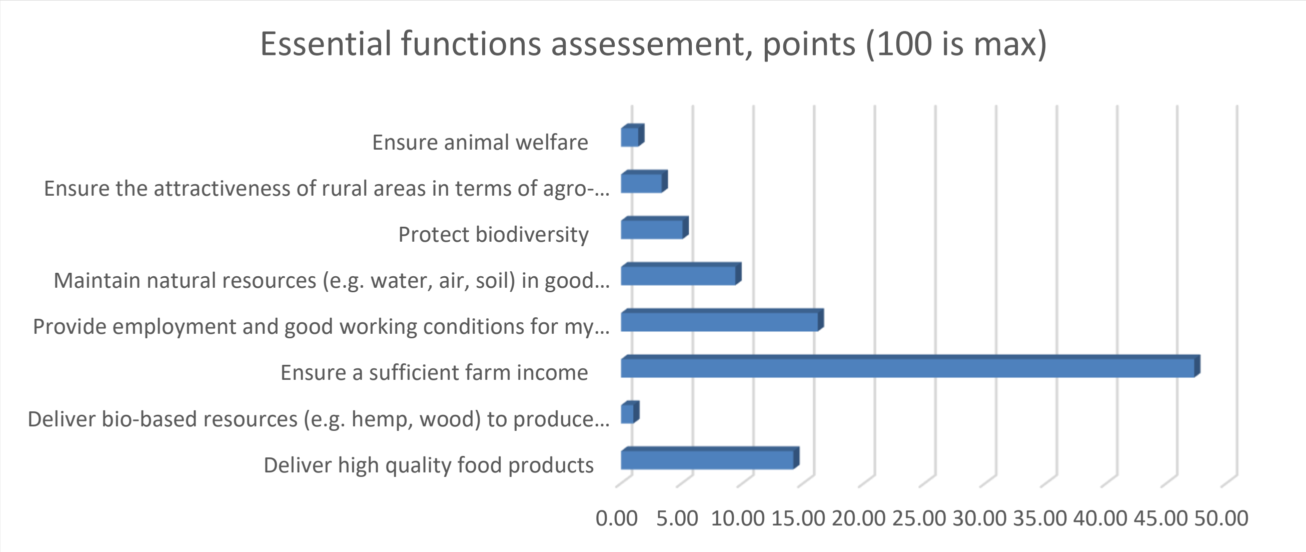


Figure 9.5. Grain farmers' assessment of essential functions, a total of 100 points are distributed between 9 potential functions.

9.5.2 Farming system

At farming system level, food production gets priority over economic viability, in contrast to the farm level (size of the bubbles; Figure 9.6). In terms of performance, in FoPIA-SURE-Farm stakeholders gave both private and public goods scores of 3 (moderate performance) or higher. However, the food production received the highest scores. The grain farmers see the delivery of private and public goods as mutually exclusive. High productivity happens at the expense of natural resources (i.e. soil fertility). This explains why the delivery of public goods is understood in general as part of policy, but not as something that requires a personal action.

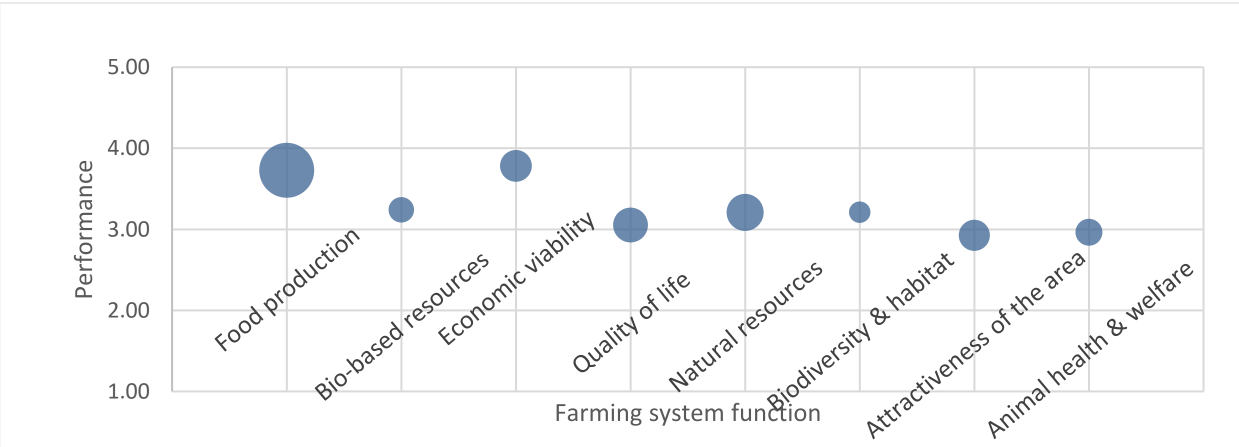


Figure 9.6. Bubble graph presenting averaged scores on performance of functions (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other, n=14

ES modelling shows that the indicator of food crop production in the farming system is extremely low compared to the average for EU and the overall region (Figure 9.7). These results do not support the results from other research methods. The farming system has a more diversified production structure and compared to the region produces more food for direct consumption. The indicator of fodder crop production in the farming system has extremely low levels, but is higher than the one at the regional level. The energy crop production indicator is (~0,4) is a good score compared to the EU average and is in accordance with the overall assessment of the region. The assessment of the grazing livestock density service shows the better capacity of the farming system compared to the region, which is result of the higher proportion of the existing meadows and grasslands.

The performance of public goods reveals a detailed view on different aspects of the natural resources but does not allow assessment of the delivery of food quality. Among the public goods, the highest score is observed for the capacity to avoid soil erosion service (0,7) (Figure 9.8). This is close to the regional level and with less diversity due to the lower difference in min-max values as a result of the existing land cover and status of the soils. It is followed by the water retention indicator (0,5) which corresponds to the average for the region, and habitat quality based on common birds (~0,4), which has a higher compared to the EU average. The low score for recreation potential (~0,18) is in conformity with the real situation due to the fact that the recreational capacity of the farming system is low. This is in line with the interviews.

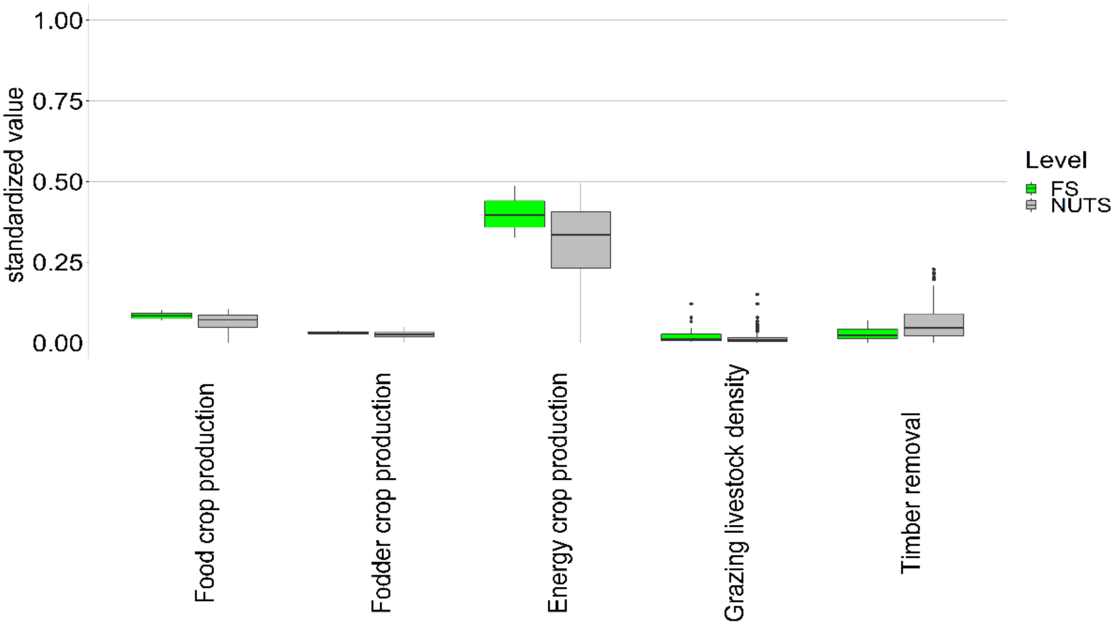


Figure 9.7. Current performance of ecosystem services related to private goods; ES modelling research.

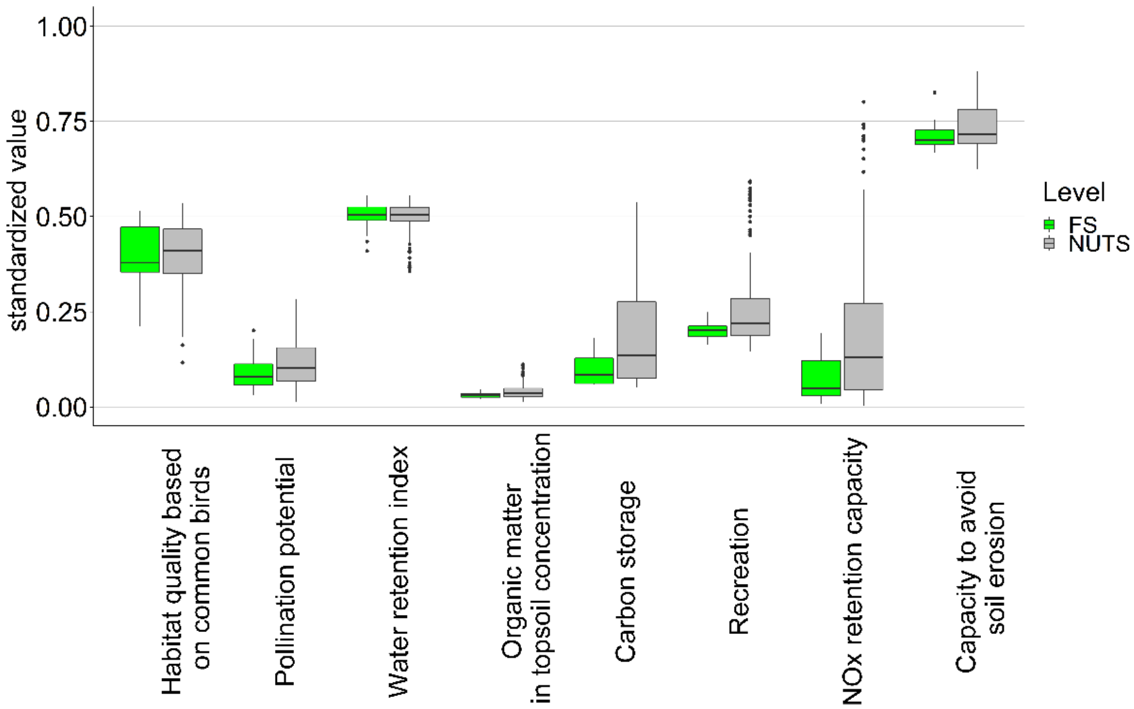


Figure 9.8. Current performance of ecosystem services related to public goods; ES modelling research.

9.6 RESILIENCE CAPACITIES

The three main capacities – robustness, adaptability and transformability are assessed across different methods.

9.6.1 Farmers and farm households

Learning interviews and demographic interviews generate detailed results revealing the robustness and adaptability capacities of grain farmers. However, they do not reveal any specific behaviors and views associated with transformability, apart from some influences from the succeeding generation, explained below.

Robustness is represented by persistence in doing the same and lack of intentions for change in the long term. Learning interviews reveal that if the circumstances do not change, grain farmers would not change anything on their farms. Demographic interviews support this by detailing that if the policy and the lack of available labor remain as they are, grain farmers would maintain the status quo for as long as it continues. However, most of the respondents report implementation of changes, indicating adaptability.

The studies show that the adaptability of farmers is evolving due to the need for small adaptations. Grain farmers adjust their on-farm production from conventional to innovative through experimenting with new technologies/varieties/crops for better economic performance, but also as a response to the main climatic challenges. They prefer more environmentally friendly production methods in order to be sustainable in the long term. It is kind of combination of resilience attitude (owning land gives them security to continue farming) but also a need of adaptation to meet future challenges and to continue the business.

Transformability is facilitated at the household level through the participation of the next generation in the current farm business. The demographic interviews revealed that some farmers start to diversify their production to non-conventional crops driven by the new image/perspective looked for by their children.

At farm level, farmers have rated the resilience capacities at a similar level: the robustness scored highest with 4.6, the adaptability and transformability, respectively with 4,5 and 4.4 which is not statistically different.

9.6.2 Farming system

At the level of the farming system, the focus group on risk management provides results in line with the interview research. Robustness is supported by farmers' commitment and attachment with the sector; traditions in the sector; no opportunity for different products; and lack of need for change. The AgriPoliS focus group complements this with findings on ensuring robustness through increased labor contributions from the farmer and close family and annual subsidies.

Nevertheless, the focus group on risk management also confirms that adaptability is achieved through undertaking diversification, modernization, innovation, and use of new varieties. Furthermore, the AgriPoliS focus group provides findings in support of the interview studies suggesting that the labor force is one of the factors influencing the adaptability of grain farmers. Building and maintaining a suitable labor force ensures mid- and long-term resilience. This happens through investment in and engagement with human capital and applies to the skilled labor type. It depends on the initiative of the farmers and is a way for overcoming the 'lack of labor' challenge.

The two studies do not provide findings on presence of transformability capacity apart from the preparation for succession by involving the next generation in the business reported in the AgriPoliS focus group.

ResAT and FoPIA-SURE-Farm do not differ from the above studies and also provide some quantitative measurements that allow resilience capacities to be compared and assessed. Both show that robustness is the most strongly supported resilience capacity. According to ResAT, the policy instruments have a short-term orientation (Figure 9.9). They help maintaining the status quo, providing buffer resources and other risk management mechanisms. Policy goals do not encourage long-term orientation but support robustness through maintaining the status quo. They also provide relatively strong support through buffer resources and other modes of managing risk.

Adaptability receives stronger support through policy goals compared to the policy instruments available, according to ResAT (Figure 9.9). A wide range of policy instruments are available for this type of resilience, but they are not relevant to the farming system of grain farmers. Nevertheless, policy support encourages mid-term orientation and aims at developing flexibility of the farm businesses. It also offers a variety of tailor-made responses but does not encourage social learning.

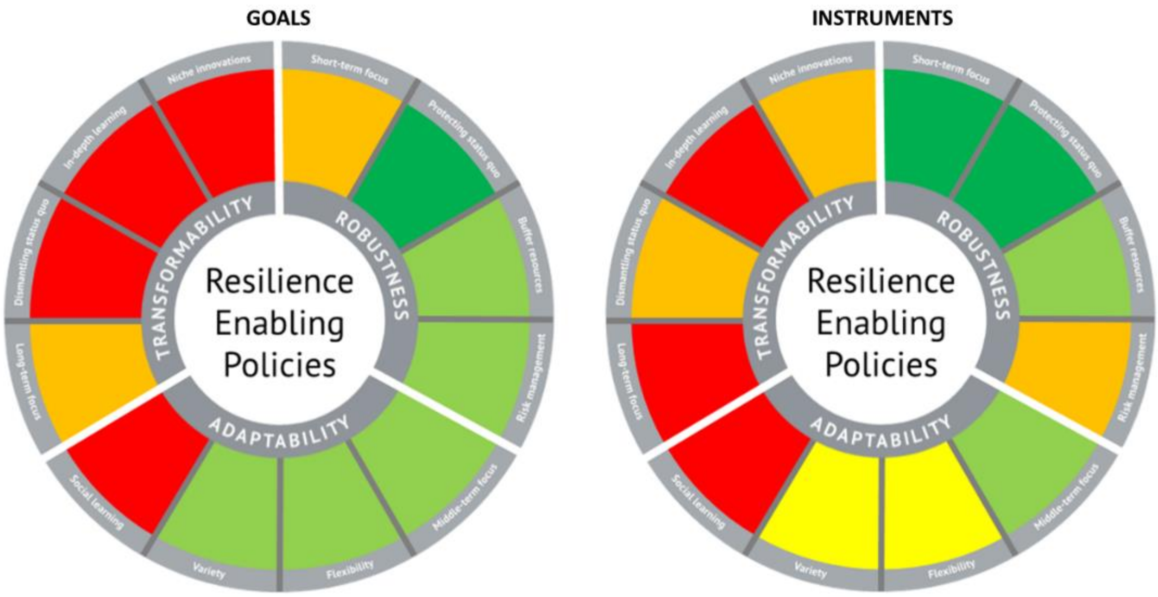


Figure 9.9. ResAT wheels for case study on the grain farming system in Bulgaria. The attributes are the key characteristics for resilience-enhancing policies. The given colors indicate to what extent the key characteristic is enhancing or constraining the resilience capacity (Red = Not enhancing or very constraining; Orange = Slightly enhancing or constraining; Yellow = Fairly enabling or fairly constraining; Light green = Enhancing or slightly constraining; Dark Green = Very enhancing or not constraining).

FoPIA-SURE-Farm identifies four main strategies of grain farmers that mostly support resilience through maintaining and increasing the typical outputs (Figure 9.10). Nevertheless, adaptability follows closely and sometimes is more supported than robustness.

Furthermore, the stakeholder analysis from FoPIA-SURE-Farm on the influence of resilience attributes on the three capacities shows that adaptability is most supported by the different attributes, while robustness remains in the second place (Figure 9.11).

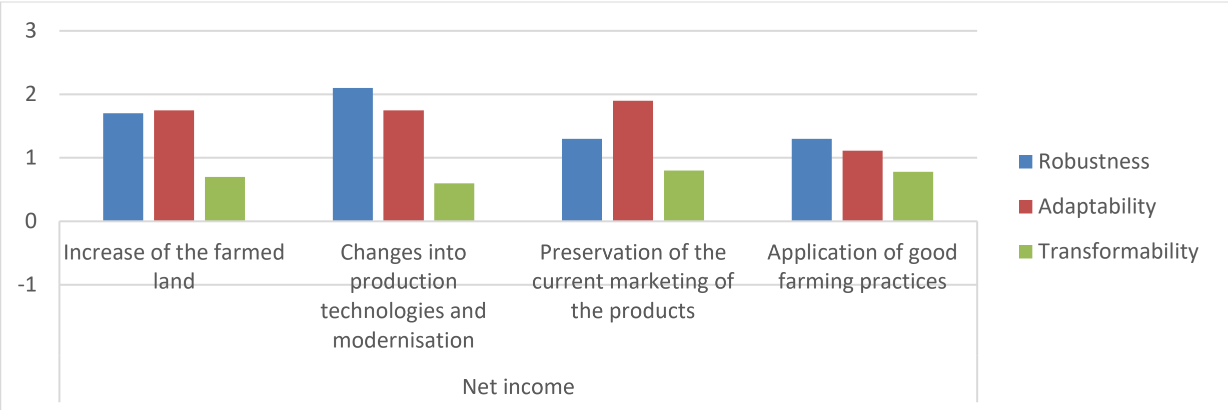


Figure 9.10. Bar graph showing average scoring of effect of strategy on robustness, adaptability and transformability of the farming system, n=14. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 a intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship.

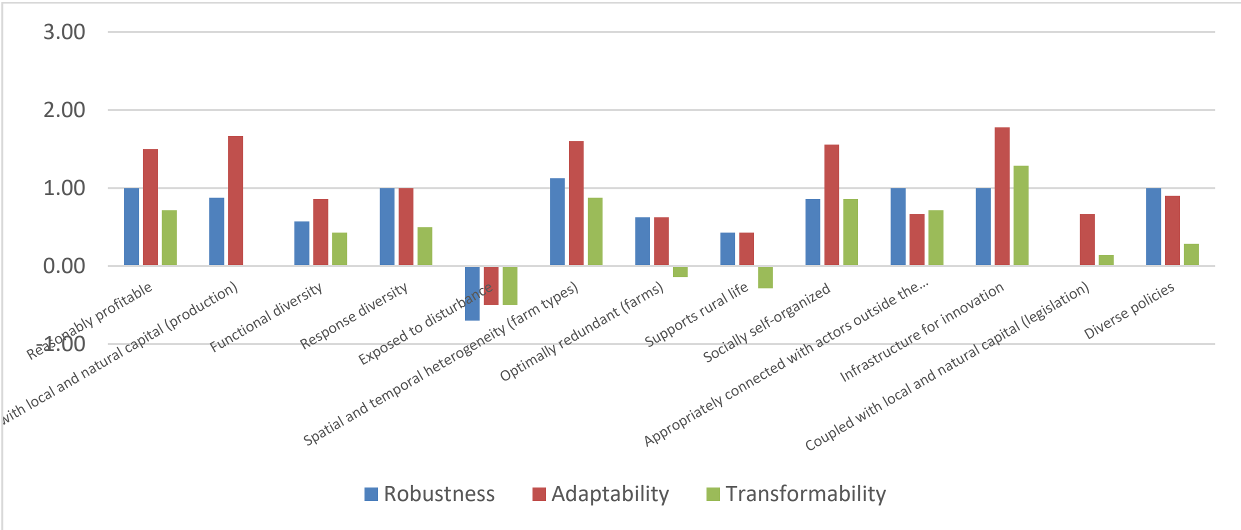


Figure 9.11. Bar graph showing average scoring of perceived effect of attributes on robustness, adaptability and transformability, n=14. Where, 0 implies no relationship; 1 a weak relationship; 2 a relationship of intermediate strength; and 3 is a strong relationship.

9.6.3 Concluding remarks on resilience capacities

The inquiries taking the perspective of grain farmers show more support to adaptability than to robustness. However, adaptability is not intentionally pursued. If there are no external factors for change, the majority may not undertake it. The need to maintain intensive production by adopting new technological developments encourages grain farmers towards adaptability rather than robustness.

These results are supported by the perspective of the farming system as well. FoPIA-SURE-Farm suggests that business growth through increasing the farm size and maintaining the same market opportunities are the contexts that require more adaptability than robustness (Figure 9.10). The strategies related to changes in technology also substantially contribute to adaptability. From the policy perspective, grain farmers are encouraged towards adaptability through the policy goals but facilitated to maintain robustness through the policy instruments. As a result, they can be expected to maintain the status quo as well as to adapt to small changes.

Transformability is least supported according to the results from all studies. There is lack of a long-term view for change which can take the farming system to a different equilibrium state.

9.7 RESILIENCE ATTRIBUTES

9.7.1 Farmers and farm households

Learning interviews show that through the learning process farmers changed their behavior. Farmers adopted different learning strategies depending on the long-term experience they gain during the years of managing the same business as well as the resources available for them. It is important that the adaptations they undertake as a result of a learning process do not require additional investments in machineries, equipment and training of workers. These experiences contribute to enhancing human capital and knowledge management. The demographic interviews suggest that at the household level, this is supported by experiential knowledge from the past through engagement in the state cooperative farms. Furthermore, grain farmers get access to new advanced knowledge through the impact (influence) of specialization (education) abroad.

Opportunities to learn through experiments, learning by others, looking for information and openness to new ideas lead to better decision-making and farm management. In this process farmers show awareness of the system boundaries and implement new technologies which preserve soil fertility (even increase it) and lead to decreasing production costs. This suggests a positive attitude to innovation that contributes to increasing resilience capacity.

In addition to the learning processes enhancing resilience, grain farmers have developed a better relationship with finance institutions. Improved access to credits is accompanied by better credit burdens acceptance. Farmers also report diversification of and increase in number of financial sources options. These developments are associated with increased investment in the form of machines and land. This suggests that the short-term view of the business is changing through the availability and use of finance and the capacity for adaptability increases.

The two interview methods are consistent in evaluating the role of policy for grain farming at a more general level. Their results are also in line with insight from the focus groups on AgriPoliS and risk management that focus on the farming system rather than individual farmers. According to the learning interviews, there is lack of incentives (policy stimuli) for enhancing the resilience of grain farmers. The demographic interviews show that lack of strategic direction of the policy and frequently changing goals hinder farmers' resilience. However, the demographic interviews suggest that financial support through policy (SAPS) allows accumulating finance for investment. Past policy options like the Special Accession Program for Agriculture and Rural Development (SAPARD) available in the period of 2000-2006 during as a special pre-accession aid and current opportunities through the rural development programs (RDP) also help investment and development of the farms. The farmers emphasize the business diversification options of the RDP, and this can be connected with potential for increasing the heterogeneity of grain farms, which is associated with better resilience in terms of adaptability.

Both interview studies are consistent in finding constraints to resilience within the access to land resources. The restricted ownership on the land constrain farmers to undertake more radical changes and adaptations. The insecurity about the size of land they could rent/lease next year as well as the possibility of territorial changes of the fields are mentioned by all of the farmers for as reasons why they do not undertake changes which require a long-term period of implementation. These constraints facilitate the development of a short-term view of the business, where crops and activities are planned on an annual basis.

Another important constraint is the broken relationship between research, education, and business. The knowledge generating part of that system (universities, schools, research institutes) is developing at a slower pace than the businesses. These results are supported by the focus group in risk management. It reports that at the level of the farming system, farmers can benefit from better relationship and communication between these institutional actors. Additional limit to accessing new knowledge is the low level of public extension services.

At the personal level, the demographic interviews show that farmers do not tend to co-operate with each other, and this is a constraining attribute that can affect negatively each of the three types of resilience. Their social relationships with other farmers also do not support resilience. This result is supported through the focus group on risk management, which reports that when collaborating, grain farmers are too focused on their private member interest.

Other constraints come from the labor force. In this respect the demographic interviews are consistent with the AgriPoliS focus group and the focus group on risk management, discussed in the next section, where the issues are presented in more detail.

9.7.2 Farming system

The ArgiPoliS focus group provided evidence for stakeholder engagement through participation of the grain farmers in vocational organizations that aim to promote their interests among policy makers. The study also suggests presence of human capital and knowledge management through active engagement in the building and maintaining of human capital on the farm. However, a constraining factor is that the farming system does not benefit from high availability and easy access to human resources. Similar to the demographic interviews, availability of human capital in the household can be a constraint to the size and specialization of the farms.

The ResAT analysis shows that policy goals and instruments provide more evidence for enhancing rather than constraining resilience. However, their effects would depend on the ability of the participants in the farming system to take advantage of them. Direct payments are the most relevant policy instruments to farmers from the case study farming system and they enhance robustness but constrain adaptability and transformability. They encourage the adoption of a short-term view towards farming, because they are distributed on an annual basis. The introduction of green payments can be considered as a way for extending resilience beyond robustness by encouraging change in production practices. However, increasing ecological requirements can be perceived as a constraint, as suggested by the focus group on risk management.

In FoPIA-SURE-Farm the most important attribute for the resilience of the studied grain system is “exposed to disturbance”. On the next place are: 1. Spatial and temporal heterogeneity (farm types), 2. Coupled with local and natural capital (production) and 3. Optimally redundant (farms) and all the three supports the adaptability of the grain farming system according to the stakeholders. In regard to the resilience capacities the highest positive rates were given to the attributes as follows: 1) for robustness: spatial and temporal heterogeneity (farm types), 2) for adaptability: infrastructure for innovation and 3) for transformability: infrastructure for innovation. “Exposed to disturbance” is overall viewed as affecting resilience capacities negatively.

9.7.3 Concluding remarks on attributes

This research employs a relatively large number of resilience attributes and they have been examined to different extents by the different studies. Combining the results helps developing a more complete picture of the resilience attributes.

Table 9.2. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance)

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Fertile soils and good conditions for arable farming in general (AP) Crops diversification (AP)	Limited by the lack of irrigation infrastructure (AP)	Diversification of the crops and territorial diversification of the plots (AP, RM)	
Openness	Looking for information and openness to new ideas (AP, RM)		Openness to new ideas and innovation (FD, RM, G)	Low level of connectedness with the scientific and educational institutions (AP, G) Low level of cooperation among farmers (FD)
Tightness of feedbacks	Introduction of green payments (AP, G)	Lack of policy support instruments dismantling status quo (FD, G) Mutual dependence between farmers and land owners and high level of competition for main production factor: land (FD)		Infrastructure for innovation (FD, G) Low level of public extension services (AP)
System reserves	Production is coupled with natural capital (AP) Improved access to credits (RM, G)	Depopulation and ageing processes in the region (FD, RM) Size and specialisation of the farms (FD, AP)	Specialisation (education) abroad (RM, AP) Knowledge management (RM, AP)	Low level of willingness for generational renewal (FD)
Modularity	Spatial and temporal heterogeneity (FD, AP)	Polarized farms' structure (FD, RM) Lack of strategic direction of the policy (AP, RM, G)	Experimentation and adaptation to local conditions (AP, RM)	

Most of the discussed studies suggest that grain farmers benefit from enabling attributes supporting adaptability. These include mostly human capital and knowledge management, and to a smaller extent, stakeholder engagement and farm heterogeneity. This is in contrast with the ResAT study, which is based on policy document analysis and reveals that the best represented resilience attributes are those supporting robustness. However, the other studies also reveal some key issues in favor of a short-term orientation. In particular, the poorly regulated land relations that constrain long-term planning of production and investment on land that is rented or leased on an annual basis.

Human capital and knowledge management develop well at the personal level, where farmers gain advanced knowledge through experience and education. There also are positive tendencies in the approach to training employees on the farm. One positive outcome from the grain farmers' personal approach to knowledge management is the experimentation at the farm level, which develops a favorable attitude to innovation. However, this attribute is not supported through collaboration with colleague farmers and other stakeholders. Better opportunities for advancing the knowledge of grain farmers are also hindered by the inefficient work of public knowledge development organizations and advisory services.

The methods considering the perspectives of farmers and stakeholders show that the views on agricultural policy represent mostly critique. As grain farmers are well-supported through the direct payments instruments, it is likely that such views are fueled by expectations for constant improvement. The policy is an important framework, and it has the potential to influence all resilience attributes. Grain farmers recognize this supporting role of policy and are motivated to pursue opportunities for taking advantage.

9.8 ADAPTIVE CYCLE

The grain farming system studied in North-East Bulgaria according to the current findings is assessed to be in the conservation phase. It is considered the dominant farming system in the region following the developments of the national economy during the past 80 years. Even the changes during the communist time did not change the main specialization of the system except the actors and structures. The current challenges (mainly related to the labor force, world market trends, climate changes and policy measures launched to minimize them) stimulate farmers to undertake actions for adaptation of the system in regard to optimize the production cost and preserve food production levels, to enhance the economic viability and to increase the quality of life and attractiveness of the area. But the main driving force will be the demographic processes, which assessment is tending to collapse (Figure 9.12), both in regard of the possibility to ensure the smooth succession process as well as to secure labor availability in quality and quantity.

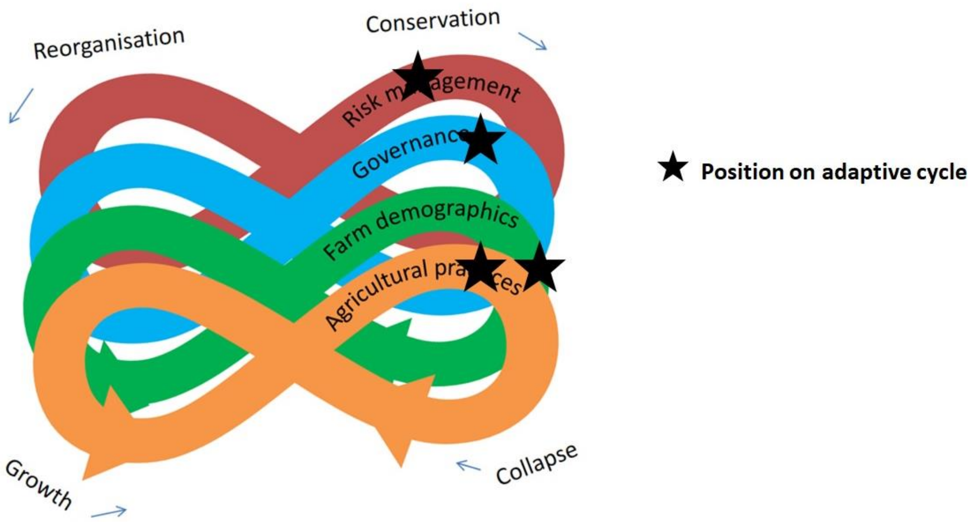


Figure 9.12. Positioning the Bulgarian farming system on the adaptive cycle of processes in agriculture.

With regard to the other processes, only for risk management the assessment shows that there is still room for growth. There is clear understanding about the need to better manage different risks as showed all the research activities (workshops, interviews and focus groups) done in the case study area. Moreover, differentiation is clear in regard to the arrangements of the different stakeholders as well as the possibility to undertake common actions with the farmers.

The study reveals interrelations between the governance and agricultural production processes and in both cases conservation does not mean close to collapse, but need for better and long-term planning of the policy implementation to secure farming system adaptability and/or transformability. One of the main issues in governance process is the still very fragmented land ownership and rent/lease relationships regulation which increase farmers' unwillingness to undertake changes. Thus it prevents them to undertake adaptive or transformative changes requiring long-term vision and stability.

In regard to the agricultural production process, the growth has been observed last decades. Currently, this growth is still possible but it is very limited from the biological capacity of the land as a production factor. The farming system has reached a point where innovations in varieties, technologies etc. improve economic performance of the farm through optimization of the costs. But the soil fertility improvements are bounded and only adaptation/transformation of the system may offer better perspectives.

9.9 STRATEGIES

Table 9.2 summarizes future strategies mentioned per process. Strategies for the future are developed mainly under the RM focus group as well as are identified as main steps planned by the single farmer and shared with us during the learning and demographic interviews. There are no big differences between the proposed strategies; only the combination of the instruments and the way of implementation differ between different farmers.

Table 9.3. Future strategies per process.

	Future strategies
Agricultural production	- New crops - New technologies - Experiments to adapt new varieties to local conditions - Diversification: crops; mixed farming, territorial diversity of plots & non-farm activities - Improved soil management
Farm demographics	- Stimulating succession - Overcoming the lack of working force - Reflexivity, open-minded, self-criticism, appreciate farm workers - Better cooperation with research institutions and universities
Governance	- More stable policies with long-term vision - Improve societal appreciation - Infrastructure improvements to attract young generation to live in rural areas
Risk management	- Optimization of production costs and securing proper assets to decrease external dependencies - Reduction of market risks and uncertainties - Exchange of information about farming and risks through participation in fairs (incl. international), exhibitions and trainings

In regard to the RM focus group five strategies were selected: 1. Use of market instruments to reduce risk (insurance contracts, futures), 2. Overcoming the lack of working force, 3. Decreasing market uncertainty, 4. Access to markets of inputs and 5. Policy. The participants in the focus group expressed their clear ideas about the contribution of the different actors and their role during each strategy implementation. Thus, an agricultural producer is the actor who has a role in each strategy, as well as the grain association ranged on the second place, and the financial services placed on the third position. Next is the Ministry of agriculture, food and forestry (MAFF) which should not participate in the strategy Use of market instruments to reduce risk (insurance contracts, futures). But it has extremely important role because the most important strategy identified to cope with risk events is the Policy.

During the focus groups certain steps for different strategies developments were identified.

In regard to the strategy "Use of market instruments to reduce risk (insurance contracts, futures)" these include: the need for agricultural producers to use trade platforms and to understand process on the stock markets and possible market instruments as well as the insurances. Another important step is the organization and dissemination of the daily market bulletin (market prices of both inputs and outputs) by the grain association.

For the strategy Overcoming the lack of working force the participants gave a lot of ideas: increasing payments and implementation of different stimulus as material and non-material benefits; improvements in working teams and conditions. In this regard the importance of institutions is high and the steps are: better organization of education and training courses.

The next strategy, Decreasing market uncertainty, can be improved by using market instruments and diversification of the production structure. The participants also pointed development of the better contacts with organizations/experts in market analysis will increase farmers' ability to react on the market changes ad decrease negative consequences as well as trainings related to RM.

The Policy strategy can improve RM in the farms only if the farmers are aware and acknowledged enough with the policy standards and rules which requires visiting specialized seminars and exchanging information for forthcoming changes of the policy. But it is crucial also that policy makers should pay enough attention to the feedback given during the seminars/meetings organized to discuss policy issues. Additionally, the associations lobby activities could be improved by increasing the collaboration with the institutions and the active role is for the association. Different materials as manuals and tutorials how farmers can apply for funding, is another important step that need to be taken. Policy as RM strategy relates also to the development of better sectorial strategy including farmers, researchers, consultants and experts where RM instruments are included.

9.10 CONCLUSION

The grain farming system in North-East Bulgaria faces many and different challenges which are recognized by all the stakeholders across the different methods applied. There is consensus on the most important challenges; from institutional (constantly changing policies and regulations and land ownership and their regulations), environmental (climate change and soil fertility), economic (price volatility) to social (depopulation, ageing and changing consumers' preferences). The general resilience of the system is assessed to be medium to low, considering the attributes performance.

In regard to the functions of the grain farming system, it performs better in provision of private goods (food production and economic viability) than in provision of public goods. The quality of life and attractiveness of the area are assessed at medium performance. The functions related with environment and nature (biodiversity and habitat together with animal health and welfare) are scored lower and need more attention.

The grain farming system operating under the current circumstances shows relatively high capacity to keep status quo and proved to be at a relatively low level of transformation. This results also from the current policy configurations, which foster robustness and neglect transformability, and adaptability receives stronger support through policy goals rather than policy instruments. Thus, the stakeholders' opinion expressed through all the field studies is that the important changes into current agricultural policy implementation and sectorial governance are among the main options to improve system resilience.

In general, farmers realize the need to adapt their decisions according to the new realities and demonstrate adaptability in their efforts to overcome challenges, like lack of labor force and climate changes, implementing new technologies and varieties, and looking for local decisions and adaptations of the innovative approaches towards the production process, technology and land management. During the years, farmers adjust their on-farm production from conventional to innovative technologies (showed preferences for more environmental friendly production methods in order to be sustainable in long term) because the crop production is the most intensive one in Bulgaria and only the innovations could bring different dimension of intensification.

10 CASE STUDY THE NETHERLANDS

Pytrik Reidsma, Alisa Spiegel, Wim Paas, Yannick Buitenhuis, Thomas Slijper, Peter Feindt, Miranda Meuwissen

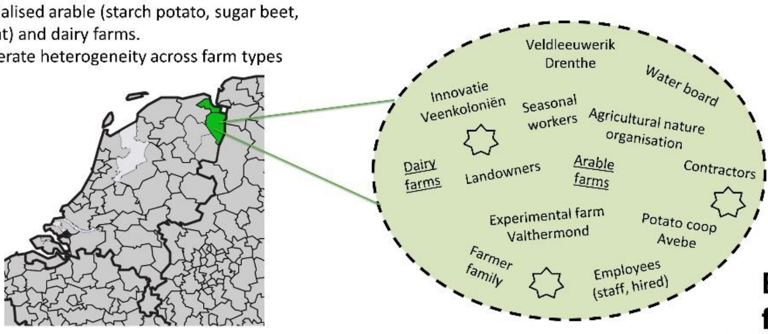
10.1 ABSTRACT

The farming system in the Veenkoloniën is an arable system, producing mainly starch potatoes, sugar beet and wheat (Figure 10.1). Main challenges include constantly changing policies and regulations, extreme weather events, plant diseases and nematodes, low economic margins, and public distrust. Ensuring a sufficient farm income, delivering high quality products and maintaining natural resources in good condition are considered the most important functions in the region. Performance of the first function is moderate, the second moderate to good, and the last low to medium. More attention is needed for protecting biodiversity and the attractiveness of the rural area, as these functions perform at a low level. Overall, the resilience of the system is low to moderate. There is a relatively high capacity to keep the status quo (robustness), while the capacity to transform is low. Current policy configurations foster robustness and neglect transformability. The resilience capacities of farms are higher than of the farming system. Also the presence attributes that enhance resilience is low to moderate. Diversity is low; modularity, system reserves and tightness to feedbacks are low to moderate, and openness is moderate. Future strategies require that farmers are better informed about risk management strategies, that policies are more stable in the context of a long-term vision, that succession is stimulated via easier access to finance, and that new crops and technologies are developed for agricultural production and high value processing.

Farming system

Veenkoloniën (NL)

Specialised arable (starch potato, sugar beet, wheat) and dairy farms.
Moderate heterogeneity across farm types



Essential functions

Private goods:
- Ensuring sufficient farm income: *medium performance*
- Delivering high-quality food products: *medium to good performance*

Public goods:
- Maintaining natural resources in good condition: *low to medium performance*

Need more attention
- Protecting biodiversity: *low performance*
- Increasing attractiveness of rural areas in terms of agro-tourism and residence: *low performance*

Challenges

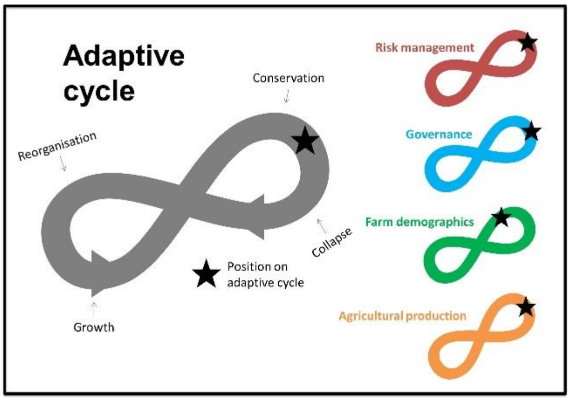
Institutional:
- Constantly changing policies and regulations;

Environmental:
- Extreme weather events;
- Plant diseases, nematodes;

Economic:
- Low margins;

Social:
- Public distrust

Adaptive cycle



Resilience capacities

Overall low to moderate resilience capacities

Relatively high capacity to keep status quo; relatively low capacity to transform

Current policy configurations foster robustness and neglect transformability

Resilience capacities of farms are higher than of farming system

Resilience attributes

Diversity: low	Soil type limits diversity of farm activities
Modularity: low to moderate	Moderate heterogeneity of farm types
System reserves: low to moderate	Production is moderately coupled with local and natural capital; Policy instruments on buffer resources and risk management
Tightness of feedbacks: low to moderate	Lack of policy support instruments dismantling status quo; Mutual dependence between farmers and potato processing cooperative (enhancing for robustness; constraining for adaptability and transformability)
Openness: moderate	Learning capacity and awareness about its importance; Moderate level of infrastructure for innovation

Future strategies

Risk management
- Exchange of non-financial and structural information about farming and risks
- Informing farmers about non-insurable and upcoming risks
- Using social media to link farmers and other stakeholders

Governance
- More stable policies with long-term vision
- Improve societal appreciation
- Facilitate infrastructure for innovation and financial support
- More attention to gender issues

Farm demographics
- Stimulating succession via easier access to finance
- More cooperation on learning
- Research on crops and breeding

Agricultural production
- New crops
- New technologies
- Improved soil management
- Circular agriculture
- High value processing

This project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 727520

WAGENINGEN UNIVERSITY & RESEARCH

SURE Farm

Figure 10.1. Factsheet synthesizing resilience of the current faming system in the Veenkoloniën.

10.2 FARMING SYSTEM

The case study in the Netherlands, is the arable farming system in the Veenkoloniën. This region covers parts of the NUTS3 regions NL111 (Oost-Groningen), NL113 (Groningen), NL131 (Noord-Drenthe) and NL132 (Zuidoost-Drenthe) (Figure 10.2). The Veenkoloniën is the defined by its soil type (peat soil) and associated farm plan, and crosses borders of municipalities. The sector considered is arable; the main farm type is an intensive, medium sized family farm, and main crops cultivated are starch potatoes, sugar beet and wheat.

The 'arable farming system with family farms in Veenkoloniën' faces challenges related to, among others, wind erosion, crop protection (nematode pressure) and relatively poor economic performance (Diogo et al., 2017). The farming system's production capacity is mainly limited by an ecological factor, namely soil type. The peat soils dominant in the region shape the arable farmers' cropping plans.

Typical for this case study, the local starch potato processing cooperative is also considered a part of the farming system (Figure 10.2), as the cooperative and farmers mutually influence one another. Stakeholder discussions led to include a range of additional actors into the farming system, e.g. the local water authority which is responsible for water transports from the distant IJsselmeer (lake) to the area, a regional study club aiming to enhance sustainability, and a regional nature organization stimulating dialogue between citizens and farmers. Furthermore, due to local initiatives to intensify cooperation between arable and dairy farms, inter alia for joint crop rotation, dairy farmers in the region are also considered system actors. The same holds for other household members due to their important role in relation to farm-level decision making.

In the rural areas of northern Netherlands, the Veenkoloniën and the neighbouring region Oldambt (statistics are initially only available for both agricultural regions together) have roughly 1,217 specialized arable crop farms, 921 specialized grazing livestock farms, and 113 mixed crops/livestock farms.

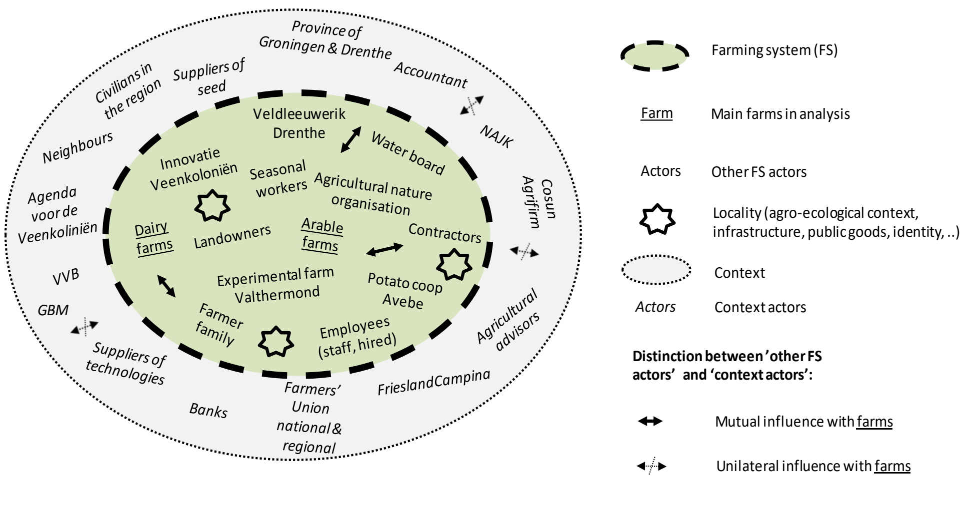


Figure 10.2. Farming system and context actors in Dutch case study area, the Veenkoloniën.

10.3 CHALLENGES

10.3.1 Overview of identified challenges

Table 10.1 synthesizes the challenges identified across methods. A synthesis at farm and farming system level is provided in the next sections.

Table 10.1. Summary of challenges across methods. The table continues over two pages.

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Arable farms	1-2 (most relevant)	3	4 (least relevant)	1-2 (most relevant)
		Dairy farms	3-4 (least relevant)	3-4 (least relevant)	2	1 (most relevant)
	Shocks	Learning interviews	Drought			Neonic ban
		Demographic interviews				
		AgriPoliS focus group				
	Long-term stresses	Learning interviews			Negative media attention	Strict manure regulations
		Demographic interviews	Impact of pesticides		Media attention	
		AgriPoliS focus group	Different approach towards fertilizing lands followed by arable and dairy farmers	Low profitability of farming No spare resources for strategic management	Farm succession Almost all operations require additional skills due to mechanization Cooperation between arable and dairy farms is often not possible	Reduction of chemicals (pesticides and fertilizers), less intensive agriculture
Households	Shocks	Demographic interviews				
	Long-term stresses	Demographic interviews			Public distrust	

			Environmental	Economic	Social	Institutional
Farming system	Shocks	ResAT				Reduction of direct payments
		AgriPoliS focus group				
	Long-term stresses	ResAT	Climate change and extreme weather conditions Plant diseases Vulnerable soils	Relative economic backwardness (in the Dutch context)	Ageing farm population	
		AgriPoliS focus group		Shortage of labour demand (increasing mechanisation) Low profitability, restricted access to credit, high land prices Current technology is hard to learn and changes too fast	Competition for labour with other sectors No/little permanent jobs are available in agriculture Lacking facilities in rural areas compared to cities Lack of skilled labor	Restricting regulations
Farming system (past challenges	Shocks	FoPIA-SURE-Farm	Wind erosion Warm and wet summers Drought Low water holding capacity and low drainage capacity Extreme precipitation	Fluctuation of prices of agricultural products	Mental health of farmer and his/her family	Change in agricultural policies of EC: decoupling of subsidies Ban on certain crop protection products
	Long-term stresses	FoPIA-SURE-Farm	Nematodes in the soil limit crop rotations Climate change	Low economic performance per hectare of land High land prices and increasing rental prices Low prices for sugar beets because of expansion after abolishment sugar beet quota	Number of farms in the region is going down Long working days Shortage of farm successors Quality of hired staff is going down	Continuous change in policies and regulations Energy transition

10.3.2 Present challenges for farmers and farm households

In the farm survey, arable farmers scored environmental challenges the highest (5.10 on average), followed by institutional challenges (4.78 on average, with no statistically significant difference compared to environmental challenges). At the same time, economic (4.53) and social (4.22) challenges demonstrate no statistically significant difference to institutional ones. In contrast to arable farmers, dairy farmers clearly scored institutional challenges as the most crucial ones (5.94), followed by social (4.72) challenges. Economic (4.11) and environmental (4.00) challenges demonstrate no statistically significant difference between each other. Tests reveal that dairy farmers score institutional challenges significantly higher than arable farmers; at the same time arable farmers score environmental challenges significantly higher than dairy farmers. The difference in economic and social challenges between arable and dairy farmers is negligible.

The results of learning and demographic interviews among arable farmers provide more details to the results of the farm survey. More specifically, drought is perceived as the major environmental challenge for arable farmers. Among institutional and social challenges, they named strict manure regulation, the ban on neonicotinoids, as well as negative media attention and hence public distrust.

Focusing on labor issues, the AgriPoliS focus group workshop revealed additional social challenges, namely demand for skilled labor due to mechanization, while currently provided training and education does not meet this demand. Furthermore, farm succession is at issue due to financial burdens, low profitability, and high land prices. Finally, collaboration between arable and dairy farmers, although seen as an opportunity, is restricted, since there are not enough livestock farmers to collaborate with and since arable and dairy farmers maintain different approaches towards fertilizing lands.

10.3.3 Present and past challenges for the farming system

Challenges at the farming system level were analyzed via the AgriPoliS focus group workshop, being devoted to social challenges, and the ResAT tool, focusing mainly on institutional challenges. In general, challenges for farms and farm household are reflected in the challenges for the farming system, while the farming system perspective reveals additional background for challenges. For instance, lack of skilled labor and farm succession are relevant for the farming system as well; yet, on the farming system level, additional reasons for the challenges are observed, namely ageing population, restricted access to credit for younger generations, and competition for labor with other sectors due to irregular working hours, lack of permanent jobs, and gender imbalance.

The FoPIA-SURE-Farm workshop discussed challenges that the farming systems faced in the past. Most of them, i.e., environmental and economic challenges, remain relevant, and hence past experience can serve as a basis for future resilience strategies. Similarly, reduction of direct payments through the convergence mechanisms introduced in the 2013/14 CAP reform and preceding expectations for this institutional shock should be considered when addressing current institutional challenges. Before and during the implementation of the new CAP, decoupling was seen as a big challenge, and it was unclear whether starch potato production would remain profitable. In hindsight, the farming system turned out to be adaptable and loss in subsidies was compensated by higher prices for starch potatoes.

10.4 OPPORTUNITIES

10.4.1 Present opportunities for the farming system

The AgriPoliS focus group workshop provided insights into current opportunities. Collaboration between arable and dairy farms is still seen as a great opportunity for circular agriculture, release of nutrients, and improved crop rotation. It was also suggested that collaboration would have been easier if arable farmers could apply their practices on lands of dairy farmers. Emerging and constantly changing technology is also seen as beneficial, especially for younger generations, as they can easier learn and better handle new technologies. The younger generation is also considered as more ambitious and hence more willing and able to adapt and transform. Finally, large farms are considered as more capable for strategic investments due to enough labour capital and financial capacities.

10.4.2 Past opportunities for the farming system

When sketching historical dynamics of 'starch potato production', 'farm income' and 'soil quality' during the FoPIA-SURE-Farm workshop, stakeholders identified opportunities that increased these important indicators in the past. Increased awareness about varieties, the availability of varieties resistant against nematodes and increased seed potato quality allowed to increase starch potato yields. In addition, breeding led to increased starch content in potatoes. Also sugar beet yields increased substantially in the past. At the same time, prices of starch potatoes generally increased. Over de period 200-2018, sugar beet prices increased until 2013 after which prices steadily declined to a historical low in 2018. Due to the cooperation with Avebe, starch potato production also provides a stable income. In the last years, Avebe has started to unlock the potential of high quality protein from starch potato. This has led to higher starch potato prices, allowing to cope with the policy change from product-based subsidies to hectare-based subsidies, which many stakeholders feared. The cooperation among farmers and industry thus provided an opportunity. Collaboration among arable and dairy farmers also has been beneficial. The availability of suitable varieties also provided room for alternative crops. At last, increased awareness about soil quality helped to shift the focus from production and income to maintaining natural resources.

10.5 FUNCTIONS

10.5.1 Farmers and farm households

The farm survey revealed that for arable farms, ensuring a sufficient farm income and delivering high quality food products are the two most important functions (and not statistically different), followed by maintaining natural resources (e.g. water, air, soil) in good condition (Figure 10.3). For dairy farms, ensuring a sufficient farm income is clearly the most important function, followed by delivering high quality food products and ensuring animal welfare; the difference between the latter two is not significant.

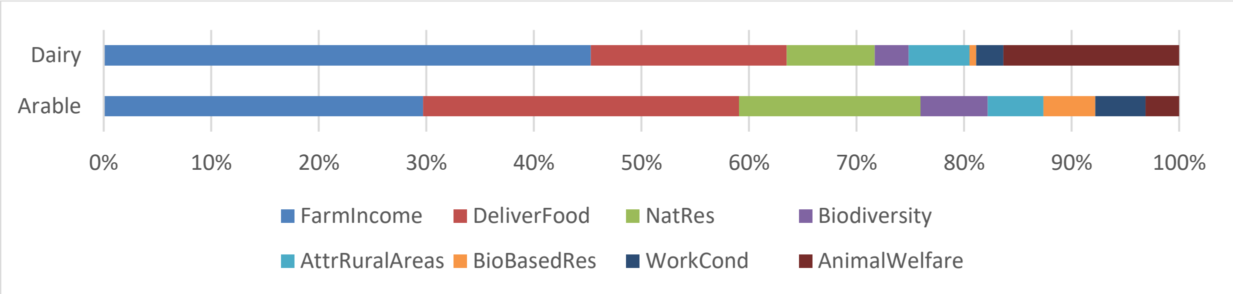


Figure 10.3. Essential functions (averages) according to the farm survey (Source: Spiegel et al., 2019).

Note: FarmIncome – ensure a sufficient farm income; FoodSupply – deliver high quality food products; NatResources – maintain natural resources (e.g. water, air, soil) in good condition; AnimalWelfare – ensure animal welfare; WorkConditions – provide employment and good working conditions for employees; BiodiversityProtect – protect biodiversity; AttractiveCountryside – ensure the attractiveness of rural areas in terms of agro-tourism and residence; BioEnergySupply – deliver bio-based resources (e.g. hemp, wood) to produce biomass and biofuels

The results were confirmed during the learning interviews among arable farmers. While some farmers indicated that income and profitability were the most important drivers of their behavior; others highlight importance of biodiversity and sustainable food production. The demographic interviews revealed that arable farmers perceive the current performance of public goods functions as relatively low ("the next generation will farm in a different way").

10.5.2 Farming system

The FoPIA-SURE-Farm workshop revealed further insights regarding essential functions for the farming system. While economic viability is still the most important function for farmers, other stakeholders scored natural resources as the most important one.

Figure 10.4 demonstrates that most important indicators (reflected by the size of the bubbles) of private goods score moderate to good, with food production performing best (3.5; first three indicators). Similar to the demographic interviews, participants of the FoPIA-SURE-Farm workshop scored current performance of public goods functions low to moderate, with exception of animal welfare (moderate to good,) and with biodiversity as the lowest one (2.3).

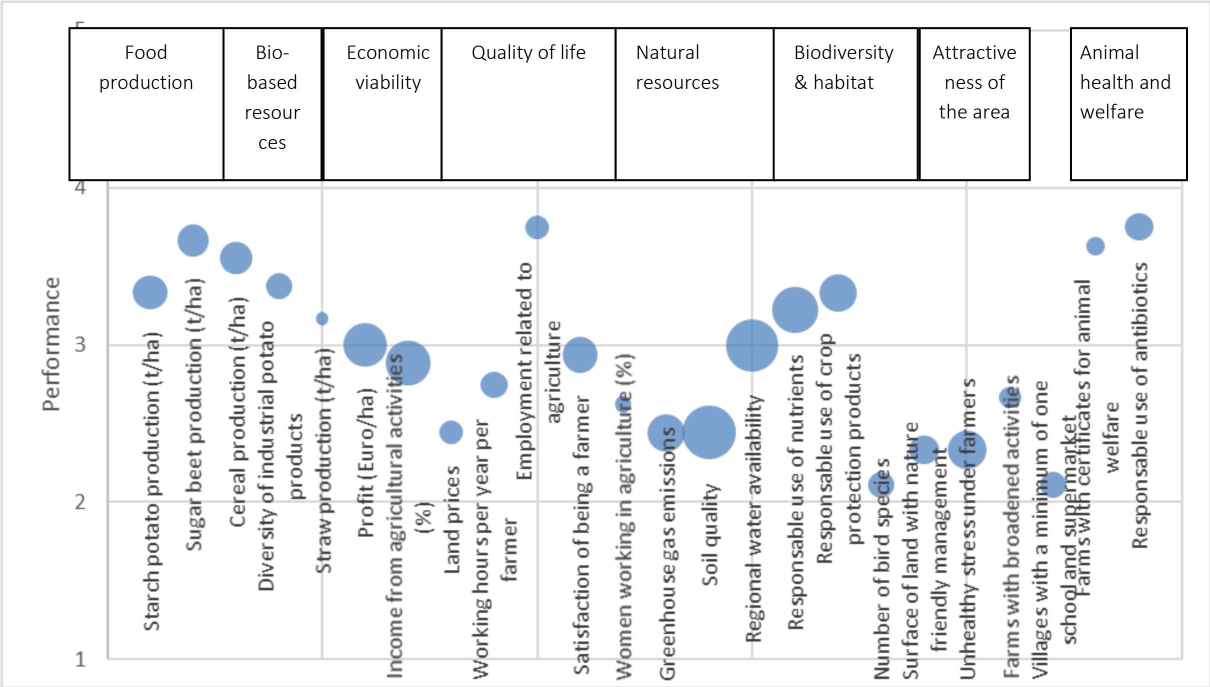


Figure 10.4. Bubble graph presenting averaged scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other. At the top, the related functions are indicated. Assessed by stakeholders in the FoPIA-SURE-Farm workshop (Source: Paas et al., 2019).

The ecosystem services (ES) assessment confirms that the current performance of food production food production is good (0.75 on a scale from 0 to 1) in the European context, and is also higher than the rest of the NUTS3 regions in which the farming system is located (Figure 10.5). Energy production scores moderately (0.45), and fodder production low (0.25), but both are higher than for the region as a whole. Grazing livestock density is lower than in the rest of the region. The value seems extremely low, but it should be noted this is the case for all SURE-Farm case study regions, and the value at NUTS3 level is actually the highest across case studies, and much higher than the European average (Chapter 15). Timber removal extremely low (<0.1), both for the farming system, and the surrounding region.

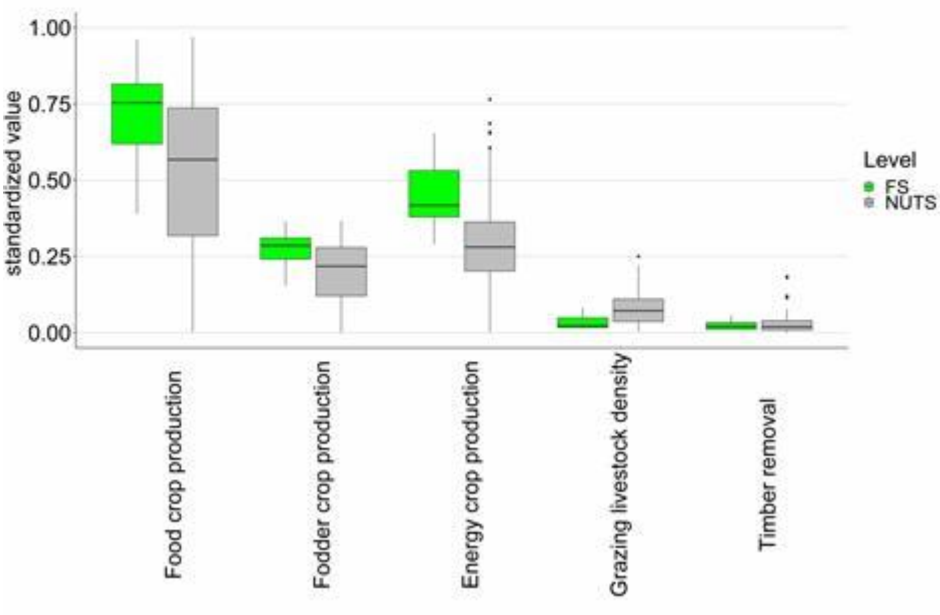


Figure 10.5. Current performance of ecosystem services related to private goods according to the ES assessment. Values are standardized, with 1 being the maximum observed throughout Europe. The farming system (FS) is compared with the NUTS3 regions in which the FS is located.

Regarding public goods (Figure 10.6), two services perform good: capacity to avoid soil erosion (~0.9) and water retention index (~0.7). The value of the first is slightly lower for the farming system compared to NUTS3, while the value of the latter is slightly higher. The performance of other services is low, and decreasing in the following order: habitat quality based on common birds (~0.3), organic matter in topsoil (~0.25), equilibrium P concentration (~0.24), recreation and carbon storage (~0.1), and pollination potential and NOx retention capacity (<0.1). It should however be noted that the European average follows a similar order, meaning that f.e. the difference between the maximum (value of 1) and average pollination potential is much larger than for habitat quality based on common birds (Chapter 15). In comparison with the rest of the NUTS3 regions, the farming system performs better for organic matter in topsoil and habitat quality based on common birds, and worse for pollination potential, carbon storage, recreation, and NOx retention capacity.

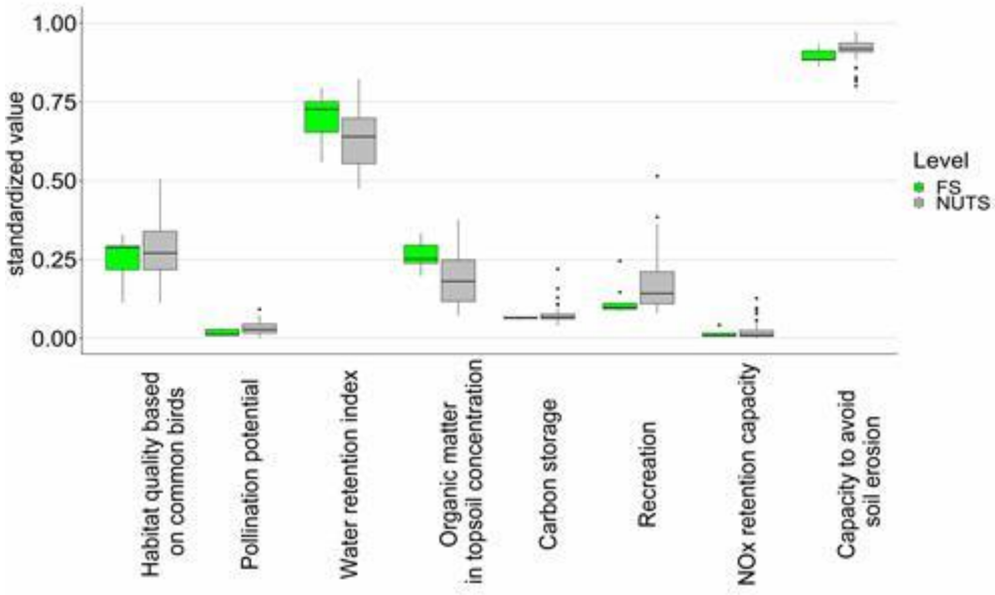


Figure 10.6. Current performance of ecosystem services related to public goods according to the ES assessment. Values are standardized, with 1 being the maximum observed throughout Europe. The farming system (FS) is compared with the NUTS3 regions in which the FS is located.

When analyzing the results of the ES assessment in the regional context, three discrepancies can be identified. The first one is more dependent on the transformation of values. Grazing livestock density seems extremely low (<0.1), according to the ES assessment. However, when comparing the value to the European average, and the rest of the case studies (Chapter 15), the value for the Dutch case study appears to be the highest; even higher than the livestock case studies. The low transformed value is because there are a few locations with extremely high values in Europe, while most locations have much smaller values. Indeed, in reality grazing livestock density is high in the Netherlands, especially in dairy regions. There are also extra milk payments for grazing. A relatively low score for the farming system seems reasonable as only around 20% of the agricultural land is grassland, and in the main municipalities, the percentage of cows that graze ranges from 19% to 76% with an average of around 40%, which is less than in the other municipalities in the NUTS3 region, and the Dutch average of 68% (CBS, 2019). Second, the eastern (generally sandy) areas in the Netherlands have problems with water retention. In the particular farming system, peat soils are dominant, but the organic matter is inactive and doesn't capture much water. Apart from precipitation, the farming system is dependent on water that has to come from the IJsselmeer towards the west of the country, and this is a problem in dry periods. So, the estimate seems too high (~0.6). Third, the farming system has problems with soil erosion, mainly wind erosion. The value for the farming system is slightly lower than for the NUTS3 level, but still extremely high. Wind erosion is not capture in the proxy, and therefore the estimate is too high.

10.6 RESILIENCE CAPACITIES

10.6.1 Farmers and farm households

At farm level, adaptability scored highest on average, with 4.73 for arable farmers, but scores for robustness (4.25) and transformability (4.14) were not statistically different (Figure 10.7). For dairy farmers, robustness scored relatively higher (4.41), but also here the difference with adaptability (4.16) and transformability (4.09) was not significant. The scores for the 16 arable and 8 dairy farmers in the Veenkoloniën were slightly lower than for the rest of the provinces Drenthe, Groningen and Friesland, specifically for adaptability.

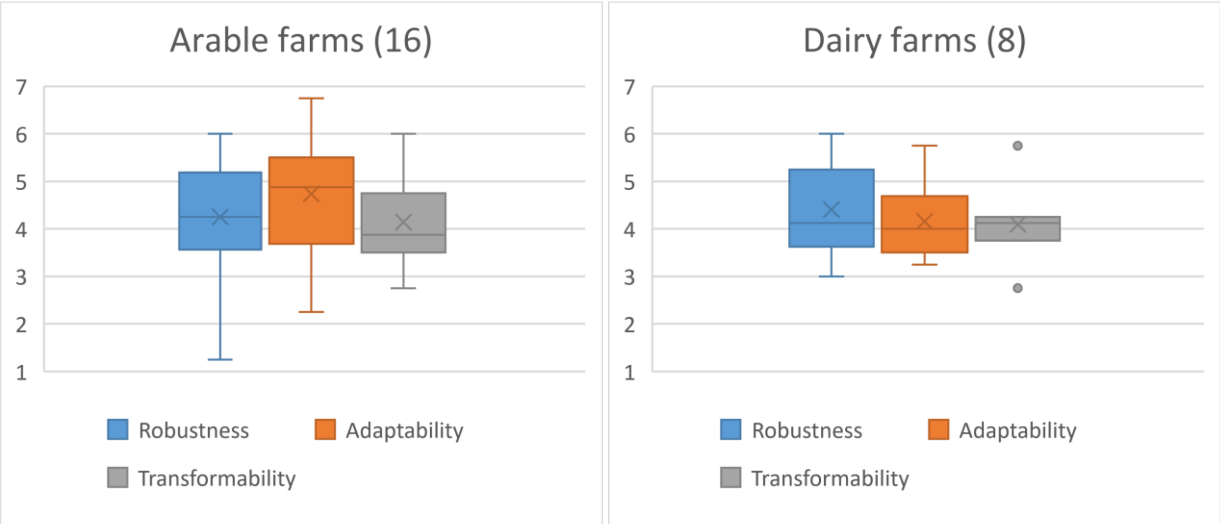


Figure 10.7. Scores for the three three resilience capacities based on the farm survey (Source: Spiegel et al., 2019).

In the learning interviews, farmers expressed that their financial performance was stable, despite the summer drought of 2018. Production smoothening resulted in stable production. This is an example of the robustness of the system.

Examples of adaptability provided in the learning interviews included experimenting with and growing new crops, investing in solar panels as an alternative energy source, labour flexibility (temporal and flexible contracts instead of fixed), and agricultural education to show and talk with citizens about farming practice. Also the demographic interviews revealed a high capacity to adapt: many innovations were mentioned that were implemented, specifically related to soil structure and renewable energy.

The learning interviews revealed that farmers were generally aware of the need to transform, but they indicated that they felt uncomfortable to start a transformation. One of the interviewed farmers transformed from primarily arable farming to agricultural recreation (camping, bed & breakfast), and farming became a secondary activity. Also during the demographic interviews farmers generally showed distressed feelings about transformation. However, wifes of farmers showed a relatively high capacity to transform. They frequently changed from off-farm employment to farm-related activities (e.g., day-care, direct selling).

10.6.2 Farming system

According to the sketches of historical dynamics by stakeholders in FoPIA-SURE-Farm, dynamics of the indicators 'profit', 'starch potato production' and 'soil quality' in the last 18 years showed robustness. Over the years, the arable farming system has shown adaptive capacity to overcome nematode pressure, years with low market prices and the change from production- to hectare-based subsidies. These adaptations have been made possible by adoption of mainly technological innovations at farm (production) level and at the processing level.

According to the stakeholders, strategies applied in the past contributed more to robustness, than to adaptability and transformability (Figure 10.8). Strategies implemented to improve soil quality had generally low implementation levels, but could have contributed relatively more to adaptability and transformability, compared to strategies to improve starch potato production and profit. However, also in relation to the latter indicators, strategies were applied that contribute to adaptability and transformability (e.g., extend knowledge, exchange land).

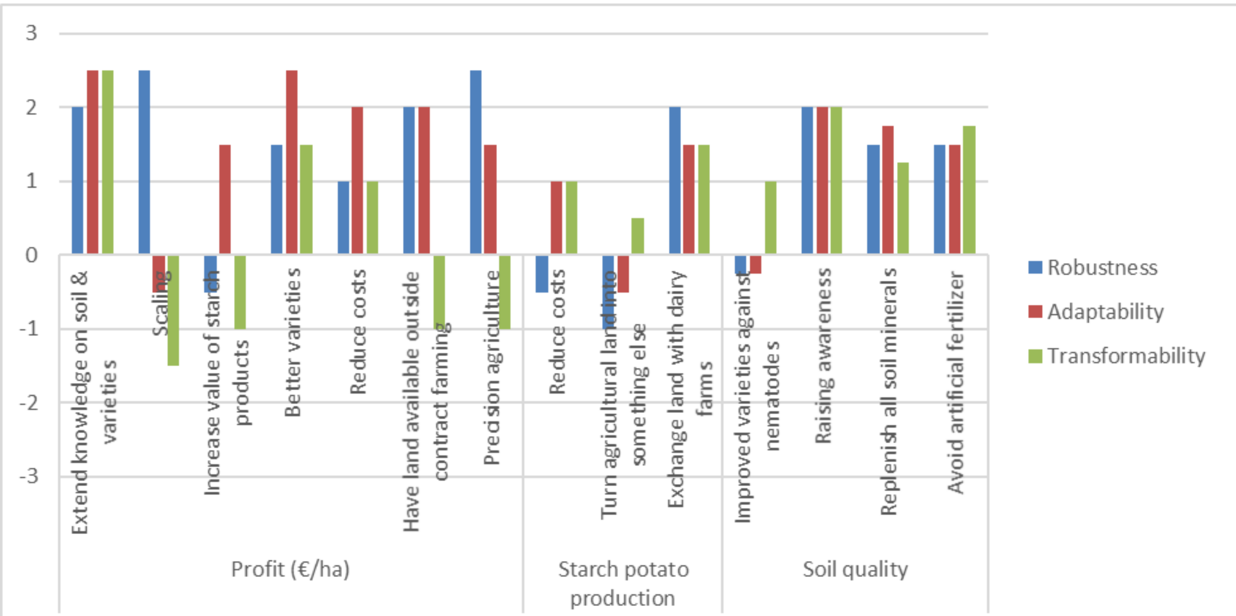


Figure 10.8. Strategies applied to cope with challenges affecting the indicators 'profit', 'starch potato production' and 'soil quality', and their perceived contribution to the three resilience capacities according to stakeholders participating in the FoPIA-SURE-Farm workshop (Source: Paas et al., 2019).

According to the stakeholders, resilience attributes are present to a small to moderate extent (see Figure 10.11), and contribute most to robustness, then to adaptability, and then to transformability (Figure 10.9). For robustness, the farming system currently depends mostly on local and natural capital and farm heterogeneity in the area (considering both presence of the attribute and the contribution to the capacity). For adaptability and transformability, the farming system depends most on local and natural capital, infrastructure for innovation and diverse policies.

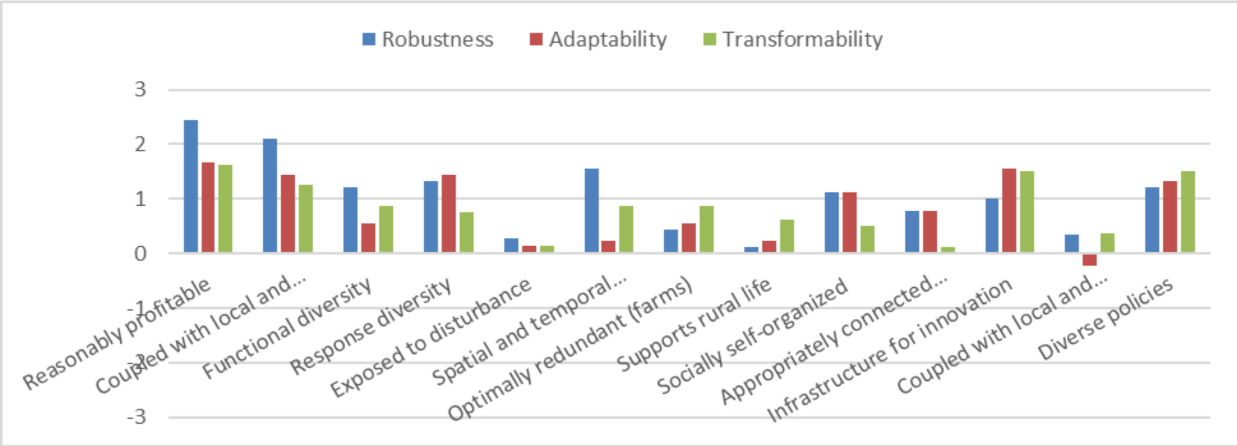


Figure 10.9. The contribution of 13 selected resilience attributes to 3 resilience capacities, according to the stakeholders in FoPIA-SURE-Farm workshop (Source: Paas et al., 2019).

The ResAT analysis made clear that the policy constellation strongly enhances the robustness of the farming system, in particular through the direct payments which provide buffer resources to stabilize incomes and which thereby support the status quo (Figure 10.10). This is complemented by support for risk management.

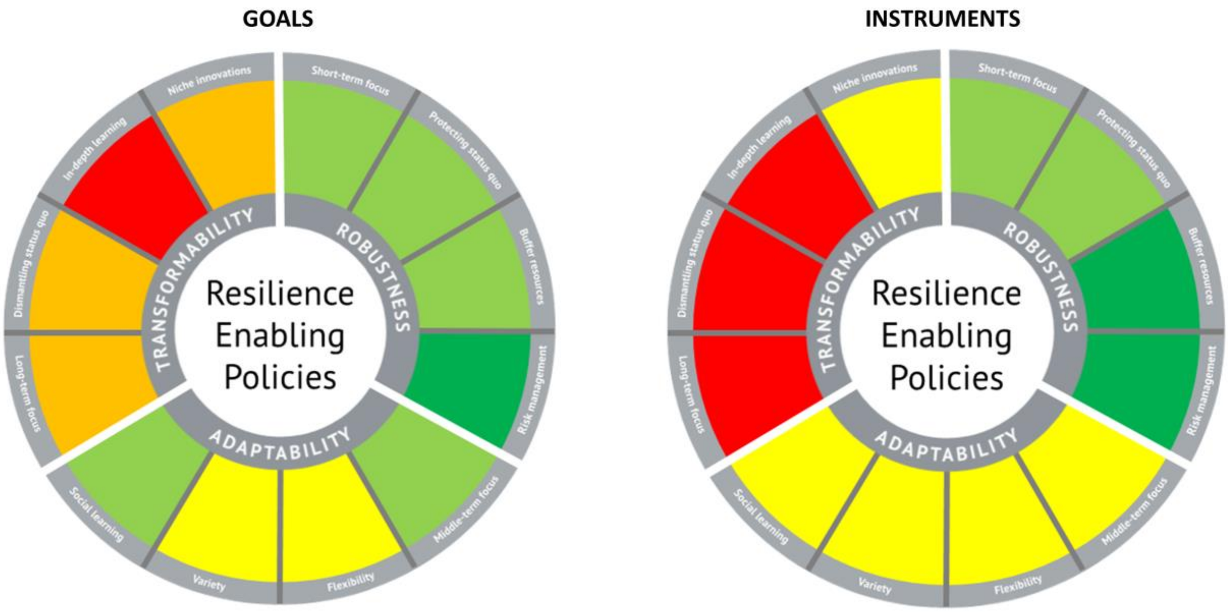


Figure 10.10. The ResAT wheel applied for the arable farming system in the Veenkoloniën. The attributes are the key characteristics for resilience-enhancing policies. The given colours indicate to what extent the key characteristic is enhancing or constraining the resilience capacity (Red = Not enhancing or very constraining; Orange = Slightly enhancing or constraining; Yellow = Fairly enabling or fairly constraining; Light green = Enhancing or slightly constraining; Dark Green = Very enhancing or not constraining).

Adaptability is fairly enabled through various rural development programs (RDP), although the adaptability orientation is stronger at the level of the goals than the level of the instruments.

Support for transformability is weak. Long-term goals are rather generic, the phasing-out of status-quo incentives is occasionally discussed but not implemented and in-depth learning is barely mentioned in the policies. However, various programs provide support for selected niche innovations, e.g. new fertilization systems, monitoring techniques and early disease detection systems.

10.6.3 Concluding remarks on resilience capacities

The farming system seems more robust than adaptable and transformable. Main strategies implemented in the past contributed most to robustness. However, some strategies applied (in relation to knowledge exchange and collaboration) contribute also to adaptability and transformability. Stakeholders also perceived the contribution of resilience attributes highest for robustness, then adaptability, and then transformability. Also the policy constellation strongly enhances the robustness of the farming system. Adaptability is fairly enabled, but support for transformability is weak.

At the level of the farmer, adaptability seems stronger than robustness or transformability. It may be that the farmers see their own capacity to adapt and transform higher than the capacity of others in the farming system. The difference may however also be due to differences in methodology; questions in the farm survey were more direct. Although farmers are aware of the need to transform, they expressed distressed feelings about this. Farmers' wives showed more transformability; they have changed activities more often. All in all, the farming system seems mainly robust, but at individual level adaptability and transformability are present.

10.7 RESILIENCE ATTRIBUTES

10.7.1 Farmers and farm households

Farmers (especially arable farmers) are strongly engaged with networks including patterns of learning. This follows from the survey (farmers attributed relatively high scores to level of integration in networks), the learning interviews (implementing best practices from colleagues or cooperating with other farmers including experimenting and sharing inputs, acquiring new information, and reflexivity), and the demographic interviews (farmer networks generate new ideas). Learning from others about novel agricultural practices, and encouraging learning, flexibility and openness to new ideas can be regarded as attributes of *openness* and *modularity* respectively.

There are however also exceptions to the level of engagement with learning and networks. This was reflected by part of the conventional farmers who are resistant to learn from organic farmers, unsuccessful learning practices (e.g. unsuccessful experimentation) which demotivated farmers to keep on learning, and, often, farmers who did not have a successor stopped investing in their farm.

Farmers also connected with various forms of *diversity*, i.e. with regard to risk management strategies, interest in multifunctional farming, cooperation between arable and dairy farmers, and husband/wife co-entrepreneurships. Also, farmers are open to think beyond the traditional farm succession model, e.g. find other job, sell at retirement age, sell but keep shares (fits under *system reserves*).

Household members contribute to *openness* (off-farm job brings realism towards need for adaptation as this is experienced as common practice in other economic sectors), *system reserves* (enjoy being part of agricultural life style) and *modularity* (frequently changed from off-farm employment to farm-related activity (day-care, direct selling).

Constraining attributes were revealed mostly at farmer level (not household level), as feelings of shame to be a farmer, and frustration about lack of long-term and stable policies.

10.7.2 Farming system

According to stakeholders, resilience attributes are only in a small to moderate extent present in the Veenkoloniën (Figure 10.11). With regard to the outputs, *diversity* is low because many cultivated land is dedicated to contract farming. The low to moderate presence of “Response diversity” indicates that there are different ways of risk management applied, but more is possible. “Spatial and temporal heterogeneity of farm types” scores best, which can be explained by the original variety of farm sizes, the recent diversification of farms and the inflow of dairy farms into the region. The retirement of many old farmers in the next 10 years and the high thresholds for taking over or starting a new farm is reflected in the low to moderate score for “Optimally redundancy of farms”. “Supports rural life” and “socially self-organized” score moderately. The moderate score of the latter attribute indicates that next to the cooperative Avebe there is room for more forms of self-organization, e.g. collaboration between farms. “Legislation coupled with local and natural capital” scores lowest, indicating that legislation is hardly adapted to the local situation in the Veenkoloniën. Examples of this by participants are the ban on certain crop protection products that actually helped to keep weeding and tillage minimal on the wind erosion prone soils. Another example given was that current legislation constrains the creation of financial buffers at farm level during good years to survive the bad years. These findings contrast with the findings from ResAT (Figure 10.10), which indicates that current instruments enable to build buffer resources and other risk management instruments, and, more generally, focus on maintaining status quo.

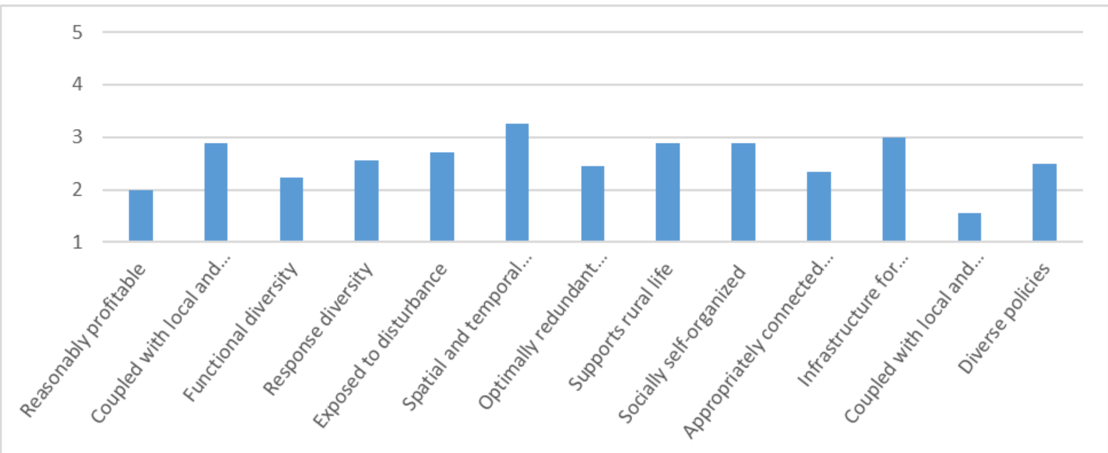


Figure 10.11. Performance of attributes on a scale from 1 (not at all) to 5 (very big extent), n=9 (Source: Paas et al., 2019).

Overall, *diversity* in the farming system is low, given the scores for “Functional diversity” and “Response diversity”. *Modularity* scores a bit higher than diversity, looking at “Spatial and temporal heterogeneity of farms” and “Redundancy of farms”. Combined, the scores for diversity and modularity indicate that there is a low to moderate degree of risk management in the farming system, and hence much room for improvement. Relatively low response diversity may also reflect mutual dependence between farmers and the potato processing cooperative.

The *reserves of the system* seem to be low with regard to “Reasonably profitable” and moderate with regard to “Production coupled with local and natural capital” and “Support rural life”. All mentioned attributes that relate to system reserves are important for agricultural production as they reflect into a certain extent the production resources capital, land and labor respectively. Farm demographics in the region are reflected by “Spatial and temporal heterogeneity of farm types”, “Optimal redundancy of farms” and “Supports rural life” and scores highest relative to the other three processes studied in SURE-Farm. *Tightness of feedbacks* of the system are considered low to moderate, looking respectively at “Appropriately connected”, “Social self-organization” and “Production coupled with local and natural capital”. Both mentioned attributes are reflecting the way the system is governed, together with the attributes “Legislation coupled with local and natural capital” and “diverse policies”. Interestingly, of these four attributes, “Social self-organization” scores highest, which is also the attribute that is most influenced by the actors within the farming system, where the other three are more boundary conditions that are most of the time beyond the direct control of the farming system actors. The relatively low diversity and modularity of policies is in line with ResAT findings (Figure 10.10), which indicate that instruments do not incentivize towards all three capacities of resilience, and do not encourage in-depth learning. *Openness* of the system is considered to be moderate, looking at the attributes “Exposed to disturbance” and “Infrastructure for innovation”.

<u>Constraining attributes</u>: policy instruments are lacking regarding tackling long-term issues and dismantling of the status quo. Also, there is a strong mutual dependence between farmers and potato processing cooperative – which seems enhancing for maintaining status quo, while possibly constraining for transformability.

10.7.3 Concluding remarks on attributes

At the system level, the status of the attributes is relatively poor with regard to each process (farm demographics, agricultural practices, risk management and governance). This implies that the individual and collective competences and the enabling environment that enhances one or more resilience capacities, and, more broadly, general resilience are at a relatively low level in de Veenkoloniën. Yet, at the farm and household level attributes perform better (more openness, diversity, etc.).

Table 10.2. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Heterogeneity of farm types (FD, RM)	Low functional diversity (AP, RM) Low response diversity (RM)	Multifunctional farming (AP, RM)	Mutually dependent on Avebe (RM)
Openness	Training provided by ABIANT (FD)	Low exposure to disturbance (RM), lack of policy instruments dismantling status quo (G)	Open-minded to change (RM)	Resistance to change (RM)
Tightness of feedbacks	Moderate level of self-organization (e.g. cooperation Avebe)(G)	Connection with actors outside the FS inappropriate (G)	Engaged in networks, exploring collaboration (G, RM)	na
System reserves	Policy instruments on buffer resources and risk management (RM), Moderate level of infrastructure for innovation (AP, G)	Relatively low profitability (AP), Production is hardly coupled with local and natural capital (AP)	Alternative forms of farm succession (FD)	Feelings of shame (FD)
Modularity		Lack of policy instruments on in-depth learning (G)	Reflexivity, experimenting (AP, RM)	

10.8 ADAPTIVE CYCLE

The farming system seems to be in the conservation phase. The arable farming system depending on starch potatoes has been dominant for the last century (the cooperation Avebe celebrated its 100 years existence in 2019). Although there seems to be some growth with regard to new (protein) products derived from potatoes, new crops, and collaboration among arable and dairy farmers, such strategies have mainly contributed to conserve the current system and being able to maintain economic viability instead of improving economic viability.

Within the system, however, reorganizations (transformations) of sub-systems have taken place. After 2005, Avebe abandoned lower quality starch markets and invested in innovative protein products, abandoning part of the production in Germany, and sacking hundreds of employees. Before 2013, subsidy flows were optimized, while afterwards the cooperation changed towards good marketing of innovative products. Nevertheless, the general structure and feedback between Avebe and farmers remained the same.

With regard to the separate processes, they are all close to the conservation phase, but for some there is still room for growth, while others are closer to the release/collapse phase (Figure 10.12). There is little room for growth in *agricultural production*, as increases in starch potato yields are limited, and the current 1:2 rotation is at its maximum and requires a release. A reorganization does not require a collapse, but can also be achieved based on incremental changes. The move towards new (protein) products, new crops and collaboration with dairy farms are part of this. In relation to *farm demographics*, growth at farming systems level seems limited, but farmers explore new succession models. In the past, increasing farm size was a main strategy to enhance robustness, but this strategy does not contribute to adaptability or transformability. Regarding *governance*, the focus has been on keeping status quo (= conservation). However, both at local, national and European level, awareness is raising that new modes of governance are needed to enhance transformability. For example, the Dutch ministry of agriculture developed a vision on circular agriculture, and the north of the Netherlands is one of the experimental locations. Lastly, regarding *risk management* there is still room for improvement.

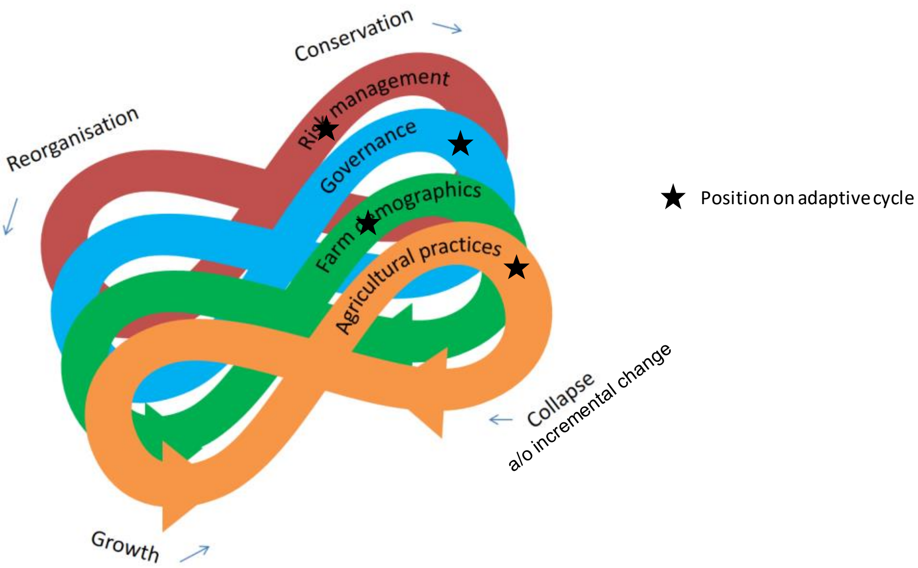


Figure 10.12. Positioning the Dutch farming system on the adaptive cycle of processes in agriculture.

10.9 STRATEGIES

Strategies for the future may focus on improving robustness in order to conserve the system, but as limited growth is possible, strategies focusing on improving transformability in order to allow for reorganization may be more viable in the long-term. Table 10.3 summarizes future strategies mentioned per process.

Table 10.3. Future strategies per process.

Process	Future strategies
Agricultural production	- New technologies (e.g. new varieties to cope with nematodes; precision agriculture). - New crops bringing more diversity and a wider crop rotation. - High value processing. - Circular agriculture (improved soil management, collaboration with dairy farmers).
Farm demographics	- Succession could be stimulated by offering farmers easier access to finance and better guidance through the succession process.
* Labour that doesn't need extra training	n.a.
* Skilled labour	- More closely connect schools with sector. - Add more practical knowledge to trainings ("in real life things are totally different")
* Farm management	- Discuss more and work together within the Veenkoloniën. (Looking for solutions outside of the region was not seen as an option, as the distance would limit good cooperation; trust between the different farms and organisations is key, which would be difficult over a greater distance.) - More research on crops and breeding (i.e., options need to be available in order to make new strategic decisions). Government regulations should make change possible.
Governance	- Develop more stable policies in the context of a long-term vision. - Policy interventions to improve the relationship between farmers and consumers to increase mutual appreciation and knowledge sharing. - More attention for gender issues (linked to man/wife entrepreneurship). - Facilitate adaptation through new infrastructure (e.g. to process alternative crops) and financial support.
Risk management	- Exchange of non-financial and structural information about farming and risks - Informing farmers about non-insurable and upcoming risks - Using social media to link farmers and other stakeholders

10.10 CONCLUSION

Over the years, the arable farming system has shown adaptive capacity to overcome nematode pressure, years with low market prices and the change from production- to hectare-based subsidies. These adaptations were possible through adoption of mainly technological innovations at farm (production) level and at the processing level. However, when considering the current level of attributes, the general resilience of the system as a whole seems relatively low.

In contrast, general resilience seems to be much more present at the farm and household level. Attributes seem to be more present at farmer/household member level than at farming system level. While they are not so positive about the system, farmers do provide examples of how they cope.

The pathway towards more robustness of the current farming system is dependent on the timely arrival of new nematode resistant varieties, Avebe's continuous efforts on starch potato product innovations and the introduction of a fourth crop with a relative high economic productivity. In the meanwhile, the farms in the farming system have to stay profitable with limited options for adaptation and experimentation, because of low financial capital and moderate local and natural capital.

However, when considering all steps of the framework (i.e. to understand *specified* resilience), farmers and households see a need to change the system (feelings of shame, low performance of public goods, 'next generation will farm in another way'). Many strategies along this route have been suggested (table 10.3). All in all, the route to resilience at system level may need to start at personal level, finding what motivates and inspires farmers, and how that helps at the farming system level. Accumulating small wins can energize stakeholders and contribute to transformations (Termeer and Dewulf, 2019).

11 CASE STUDY UNITED KINGDOM

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11.1 ABSTRACT

In this chapter we assess the resilience of the arable farming system in the East of England, UK, using the framework developed for the SURE-Farm project by Meuwissen et al. (2019) (Figure 11.1). The farming system consists mainly of large-scale family and corporate arable farms, growing cereal (mostly wheat and barley) and non-cereal crops. The challenges, functions, resilience capacities and attributes, and risk management strategies were identified and assessed via a series of interviews, workshops, focus groups and surveys conducted with a range of stakeholders from the farming system, including farmers, business advisors, bankers, and individuals from farming unions, industry organizations and policy bodies. In terms of challenges, Brexit and the uncertainty surrounding the UK's future market and institutional arrangements with the UK is perhaps the most important current issue, which is strongly linked to other significant challenges such as fluctuating prices (market and input), regulation of plant protection products and labor supply. There is significant room for improvement in the performance of most functions of the farming system, while the role of farming itself is currently under discussion in the UK, with a shift towards conservation farming and a more environmentally-focused agricultural policy possible after Brexit. Resilience capacities were assessed at the farm level and farming system level, and, although the overall resilience of the system appears to be low, there are indications that adaptability and transformability may be higher at the farm and household level. The analysis of future strategies for enhancing resilience show that a wide range of approaches is desirable, with strategies focusing on transformability thought to be particularly important considering the UK's planned departure from the EU.

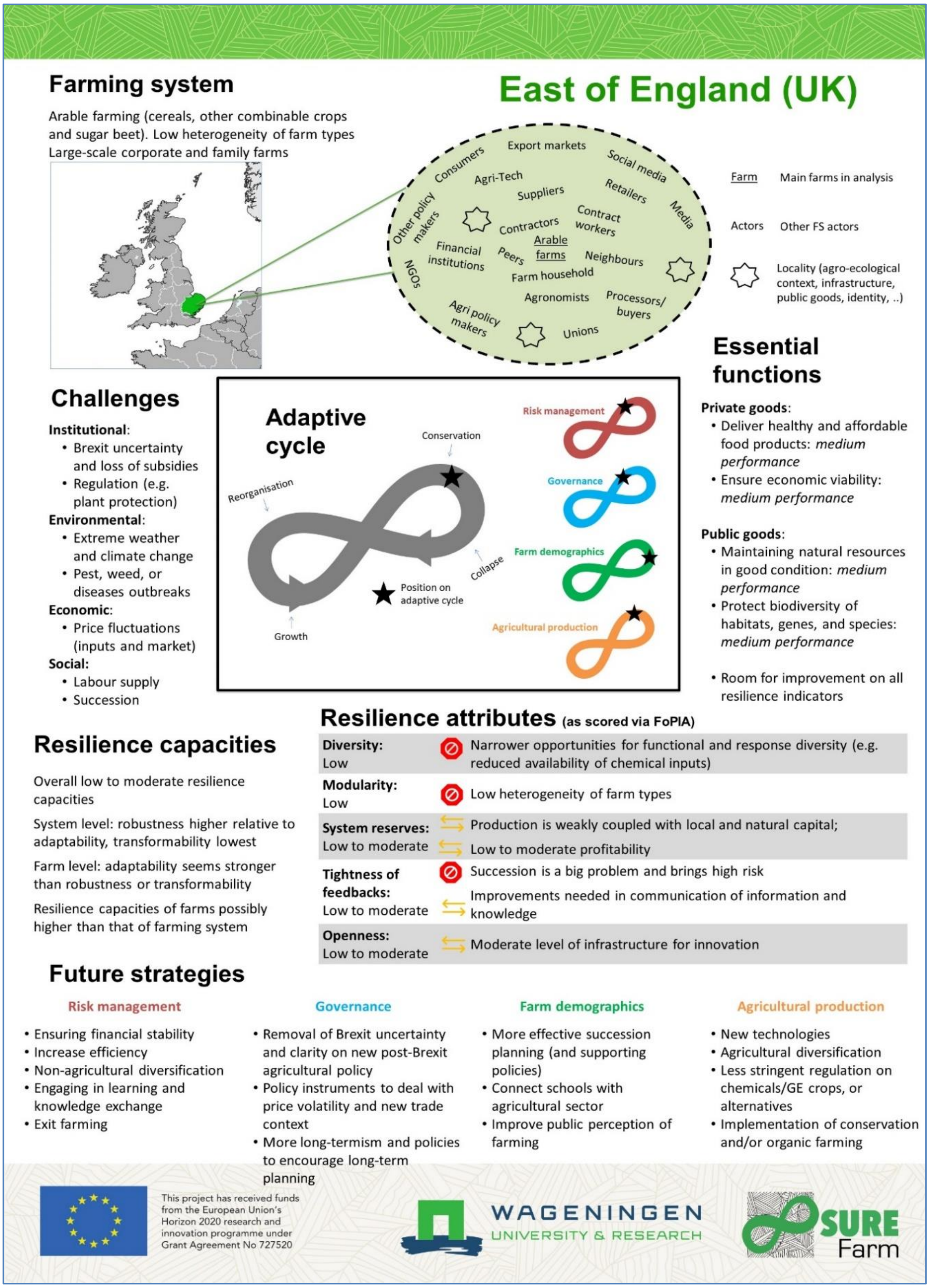


Figure 11.4.Factsheet synthesizing resilience of the arable faming system in South East England, UK.

11.2 FARMING SYSTEM

The case study of the United Kingdom (UK) investigates resilience and sustainability of large-scale arable farming - the average size of a farm in the East of England is 118 hectares, larger than the English average of 87 hectares (DEFRA, 2017). The case study area is in the East of England region (Figure 11.2) where this type of agriculture prevails due to fertile and extensive agricultural land which results in high production of arable and horticultural crops (Deliverable 3.1 – Bijttebier et al. (2018)).

Figure 11.2. East of England UK case study area (NUTS 1 code: UKH)

Agriculture is a major industry in the region, with the value of output from farming in 2016 estimated at £3.4 billion (DEFRA, 2016). The East of England is known as the UK's 'breadbasket' and is responsible for one third of the country's cereal production, as the climate and soils are well suited to growing cereals and other combinable crops. About half (54%) the agricultural land in the East of England is used for growing cereal crops for both human and animal consumption (DEFRA, 2016), with a further 29% classed as general cropping. Sugar beet is grown in rotation with cereals with the area producing more than two thirds of England's sugar beet crop. Other crops such as carrots, potatoes, oilseed rape, fruit, salad crops and pulses are also grown. The region is also important for pig and poultry farms.

Wheat and barley are the main cereals cultivated in the region. Other non-cereal crops are grown as well, such as potatoes, mustard and squash. As a combined effect of population concentration in cities (and thus a desertion of the countryside) and of the extensive flat agricultural landscape, the farms are mainly large-scale family or corporate arable farms. In the last ten years the size of farms has increased considerably as the number of farming businesses has decreased by more than 40%, while the farmland surface area has remained the same.

In the D5.2 FoPIA workshop, a conceptual overview of the arable farming system in the East of England was sketched out and the main actors within the system identified. Figure 11.3 shows a visualization of the outcomes of these discussions, where the main actor groups are arranged according to the level and nature of influence that actors within each group have on farms and the farming system (the greater the influence, the closer to the center of the diagram).

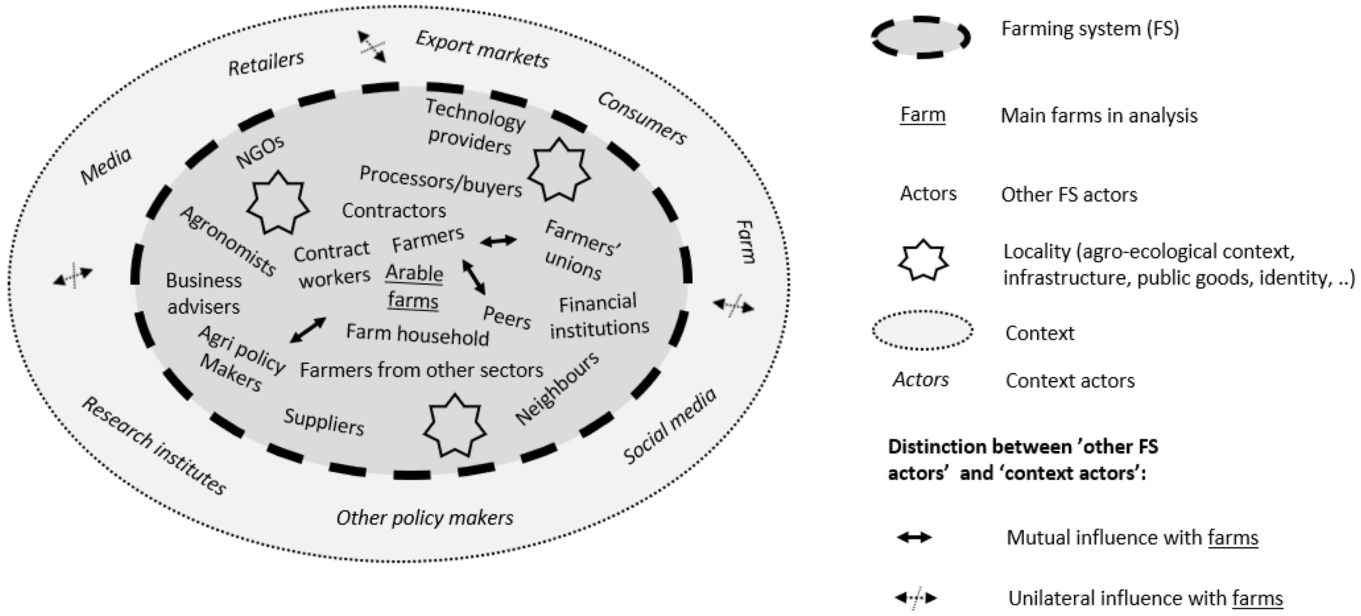


Figure 11.3. The main actors in the East of England arable farming system

11.3 CHALLENGES

Table 11.1 below synthesizes the challenges in the East of England farming system identified across all methods.

Table 11.1. Summary of challenges across methods.

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Arable farms	4 (least relevant)	1 ***(most relevant)***	3 (least relevant)	***2 (most relevant)***
Farmers	Shocks	Learning interviews	Drought / extreme weather Loss of subsidy New pest and disease outbreaks	Volatility in grain prices High input prices	Succession Changing societal expectations and public perception	Regulation of plant protection products (e.g neonics, glyphosate Changing focus of agricultural policy to public good provision
Farmers		Demographic interviews	Black grass	Market volatility		
Farmers	Long-term stresses		Maintaining soil health	Cash flow Debt Increasing cost of labor	Negative media attention Availability of skilled labor is reduced	Brexit Trade relations and access to markets
Households	Shocks	Learning interviews	Drought		Health and isolation	
Households	Long-term stresses	Demographic interviews	Climate change Disease and pests	Cost of succession / inheritance Debt	Public distrust Working with family members	
Farming system	Shocks	Risk management focus group and FoPIA	Extreme weather conditions Plant diseases		Environmental lobby groups	Brexit and UK agri policy
Farming system	Long-term stresses		Climate change Vulnerable soils	High levels of debt Exchange rates Low profitability of farming (cost of food does not reflect true price) Maintaining soil health	Labour supply Succession Changing consumer preferences Physical and mental stress of farming - health	Loss of single farm payment trade relations and access to markets Bureaucracy (e.g. difference between government agencies, admin for grant applications)

11.3.1 Farm level

In the farm survey (D2.1; Spiegel et al., 2019) arable farmers (n = 200) scored economic challenges the highest (mean = 5.15), followed by institutional challenges (mean = 5.04), social challenges (mean = 4.9) and environmental challenges (4.5). Table 11.2 shows the breakdown of mean scores by individual challenge type, which provides a more detailed understanding of how farmers perceived the various individual challenges. This shows that although economic challenges are rated as the most important when aggregated, the single most important individual challenge is an *institutional* one (*reduction in subsidies),* with a *societal* challenge also ranked highly (*lack of appeal of farming as a career* – placed 4th).

Table11. 2. Mean scores for the responses to D2.1 farmer survey Q25 (challenges to the farm)

Challenges	Mean score *(descending)*
Reduction in direct payments of the Common Agricultural Policy (CAP)	5.85
Persistently low market prices	5.77
Persistently high input prices (e.g. fertiliser, feed, seed)	5.76
Lack of appeal of farming as a career/profession	5.53
Strict regulations (e.g. environmental, animal welfare, or competition)	5.53
Market price fluctuations	5.31
Low bargaining power towards processors and retailers	5.27
Limited ability to work on the farm due to illness, divorce or other personal circumstances	5.25
Input price fluctuations (e.g. fertiliser, feed, seed)	5.12
Low bargaining power towards input suppliers (e.g. fertiliser, feed, seed suppliers)	5.12
Persistent extreme weather events (e.g. floods, droughts, frost)	5.04
Late payments from buyers	4.93
Public concerns for example about pesticide use, glycosphate and fertilisers, food safety etc	4.92
Uncertainty about the future UK agricultural policy	4.88
Low soil quality	4.76
Limited availability of skilled farm workers	4.04
Access to EU markets	3.90
Limited access to loans from banks	3.90
Pest, weed, or disease outbreaks	3.73

The results of learning and demographic interviews provide deeper insight into the challenges faced by farms. For the learning interviews, these included various ongoing or sudden challenges, such as volatile commodity markets, problems with cash flow, an increasing frequency of extreme weather events, shifting policies and changing societal expectations. The demographic interviews highlighted challenges such as farm succession, labor supply, isolation, health (including mental health) and the difficulties of working with family. Other important challenges included climate change (and the structural changes required to adapt) the regulation of plant protection products, particularly neonicotinoids (e.g. oilseed rape) and glyphosate (e.g. impact for no till farming).

The topic of Brexit featured regularly in the face-to-face farmer interviews and the UK's forthcoming withdrawal from the EU is a hugely important overarching issue that is linked to many of the present and future challenges faced by arable farmers in the East of England. There was (and still is) much uncertainty around what a new post-Brexit agricultural policy will look like. The loss of the single farm payment and a move towards public money for public goods is likely to result in more conservation farming, or a shift from food production to the provision of environmental services. Some farmers, particularly those already involved in conservation farming, welcome this, others are fearful that such a policy undermines farming's food production function. Future access to EU markets is also a critical issue, and there is as yet no clarity on what the future UK-EU agricultural trading landscape might look like, and how this will influence the type of crops grown or farm specialization.

11.3.2 Farming system level

Challenges at the farming system level were discussed during the D2.4 risk management focus group. In terms of the challenges facing the East of England arable farming system, focus group participants broadly agreed with the list of top ten challenges extracted from the D2.1 farmer survey (Table 11.3), though participants were keen to point out that individual challenges are in reality interdependent, citing Brexit as an example of an overarching challenge that encompasses several of the other challenges listed.

Stakeholders at the FoPIA-SURE-Farm workshop discussed some of the challenges that the farming systems faced in the past. Most of them, including the environmental and economic challenges, are still relevant today and experience of coping with these challenges can serve as a basis for future resilience strategies.

Table 11.3. The main challenges facing the arable farming system in the East of England CS area, extracted from the D2.1 farmer survey and discussed and approved during the D2.4 risk management focus group

	Top challenges (expected in 20 years)	Frequency
1	Profitability / economic sustainability	100
2	Brexit	69
3	Agrochemical regulations/restrictions	53
4	Labour supply	34
5	Environmental restrictions / sustainability	28
6	Politics / regulations	27
7	Climate change	19
8	Marketing / market volatility	19
9	Subsidies	17
10	Succession	17

11.4 OPPORTUNITIES

11.4.1 Present opportunities for the farming system

The learning, demographic and policy interviews, and the risk management focus group provided insights into current opportunities, many of which are policy related. These include:

- *Policy (CAP and ELMS)* - One of the major influences on the UK farming system under the CAP is through subsidies. This has provided both income support and helped to maintain land prices – which has enabled farm businesses to borrow on the strength of a good land price. However, a number of farmers felt that innovation and development of the sector has been stifled by CAP, particularly in terms of turnover of land (making expansion difficult) and people, the introduction of new ideas, techniques and methods. It was suggested that the CAP stifles innovation as it allows farmers to farm how they want without worrying too much about economic pressure. A new policy framework for UK agriculture could help to promote and facilitate innovation and the use of technology under a new Environmental Land Management scheme (ELMs), and provide a new income stream through payment for public goods.

- *Policy (Plant protection products)* - Current concerns are around a potential ban on glyphosate (e.g. implications for no till farming) and the current ban on neonicotinoids (e.g. impact on oilseed rape as there is very little other products available to deal with the turnip yellow virus that can reduce yield by up to 50%). Gene-edited crops which would mitigate against the ban on agrochemicals receive the same stringent legal status as genetically modified (GM) under EU law, but this (and the status of glyphosate and neonicotinoids) has the potential to change after the UK's withdrawal from the EU.
- *Diversification* - This can either be through diversifying crops or agricultural specialization or by diversifying into non-agricultural activities, such as renting out farm buildings, renewable energy or agri-tourism. More effective policies are required to promote diversification, provide funding for investment in diversified activities and provide more opportunities for diversifying businesses by reforming the planning system.

11.4.2 Past opportunities for the farming system

When sketching the historical dynamics of *biodiversity, productivity* and *soil quality,* during the FoPIA workshop, stakeholders identified opportunities that increased the resilience of these important indicators in the past. The workshop group, working around the *diversity and abundance of key farmland species* indicator (simplified to "biodiversity") mapped out the dynamics of biodiversity in relation to changes in environmental legislation. They observed a continuous decline in general biodiversity, but a positive response and the beginnings of a recovery of biodiversity in some farmland species (particularly farmland birds) following the introduction of agri-environment schemes (Environmental Stewardship Scheme) by the UK Government in the mid-2000s. Other factors such as grain prices, ecological focus areas (EFAs) and the three-crop rule were also noted as elements that can improve farmland biodiversity, and the analysis demonstrated the potential of agri-environment related policy interventions as an opportunity for improving biodiversity.

In the past, farmers have taken advantages of numerous opportunities to maintain and increase the *productivity* of the arable farming system in the East of England. These have included: a) collaboration between farmers to improve economies of scale through shared investments in tools and equipment; b) an increase in the size of the area farmed by a single farmer which increased the output/unit of labor over the years, and which also contributed to the reduction in costs of farming; c) peer learning (via informal and formal learning and knowledge exchange activities), which allowed for a spread of the necessary knowledge to increase productivity; d) agricultural diversification, which was used for increasing productivity by, for example, improving soil conditions which increases productivity of the land; e) embracing opportunities for non-agricultural diversification, which led to increases in productivity and farmland biodiversity, which in turn provided enhanced ecosystem services to crops allowing for increased productivity.

Lastly, the FoPIA workshop explored the opportunities realized by farmers in discussions around the resilience of the *soil quality* indicator. Participants noted a gradual long-term decline in soil quality on arable farmland in the CS region, mainly caused by the use of manufactured fertilizers, (which add nutrients without organic matter), the use of winter crops, such as wheat and oilseed rape, and a decrease in livestock tenancy. The recovery in the last few years is mainly due to an increase in soil awareness, leading to a change in mindset, causing farmers to make new efforts to improve soil quality. The groundswell of soil awareness is the result of a gradual build-up of soil awareness in the last decade. Initial improvement of awareness started with the soil protection reviews required for the single payment schemes, setting in motion efforts to reverse the trend of soil degradation. This resulted in the creation of ecological focus areas (EFAs) increasing the soil awareness by supporting different management techniques such as cover crops, direct drilling, no-till farming; and by underlining the importance of soil parameters such as organic matter or the presence of earthworms. This caused, in turn, an upsurge in soil awareness leading to the aforementioned change in mindset and improvement of the soil quality.

11.5 FUNCTIONS

11.5.1 Farmers and farm households

The results of the farm survey (Figure 11.4 - overleaf) revealed that farmers thought the most important functions of a farm were *maintaining natural resources in a good condition* (199 responses), *ensuring a sufficient farm income* (197 responses), and *delivering high quality food products* (191 responses). The results are broadly reflected in the learning and demographic interviews where many of the farmers talked about the importance of their role as custodians of the countryside, whose job it is to farm sustainably and protect and preserve the environment and biodiversity for future generations. Other farmers however seemed less environmentally minded, taking a view that farming is a business first and foremost, with income and profitability appearing to be the most important drivers of their behavior. The UK's planned withdrawal from the EU and the resulting loss of the farm payment is a subject that provided a catalyst for discussion around the role of the farm, and the tension between the provision of environmental services and food production. While some farmers, particularly those already involved in conservation farming, welcome the possibility of a more environmentally focused agricultural policy and a move towards payment for public goods, others are fearful such a policy would undermine the food production function of the UK farming system.

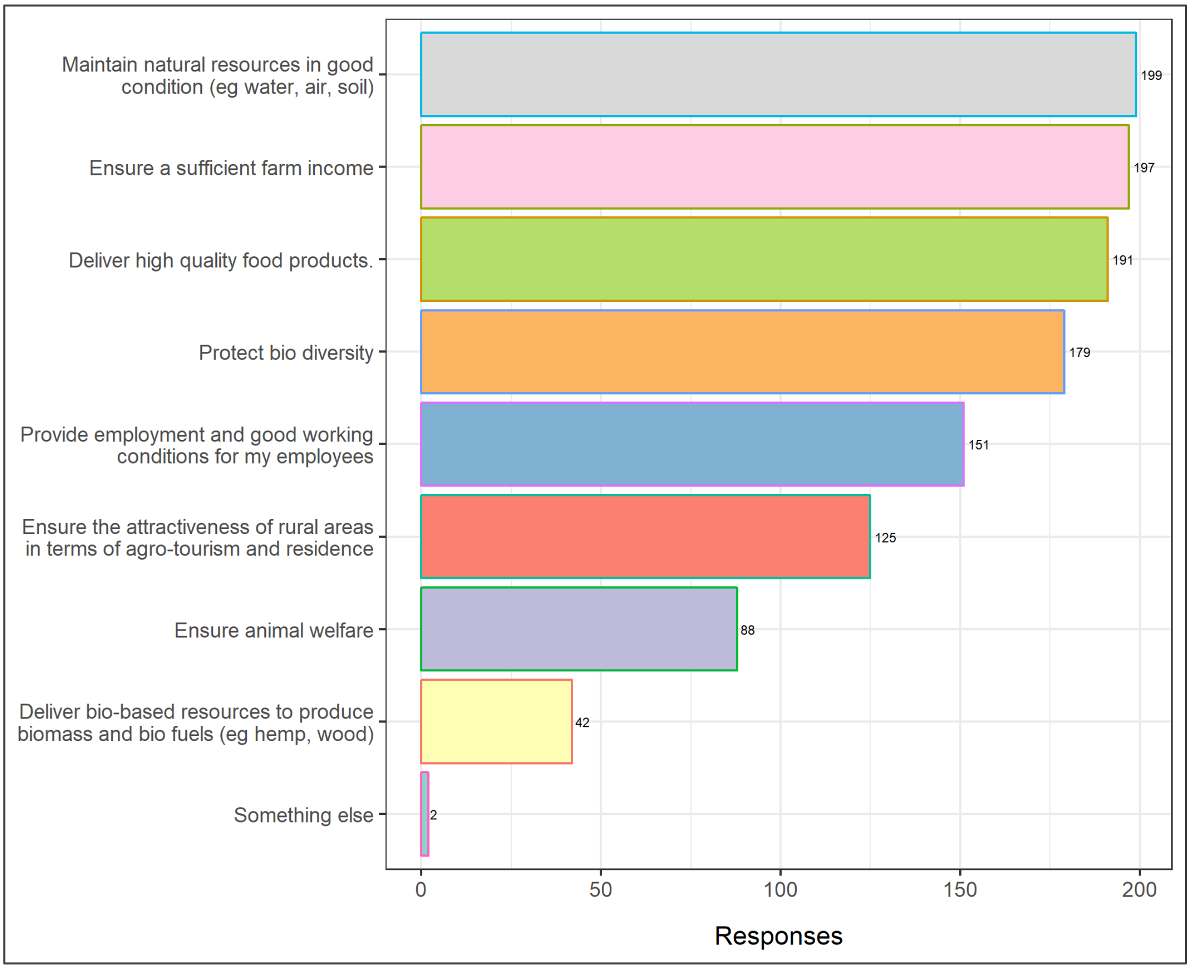


Figure 11.4. No of responses to D2.1 farm survey Q23 on the importance of farm functions

11.5.2 Farming system

The FoPIA workshop revealed further insights into the essential functions of the farming system. *Food production, economic viability* and *natural resources* were also rated as the most important functions at a farm system level (Figure 11.5 - overleaf), though food production and economic considerations were rated as being more important than the maintenance of natural resources, which differs from the results of the farmer survey. Table 11.4 shows a breakdown of the scoring by respondent groups – as perhaps might be expected, participants in the NGO group scored *natural resources* more highly in relation to economic and food production functions than those in the farmer group.

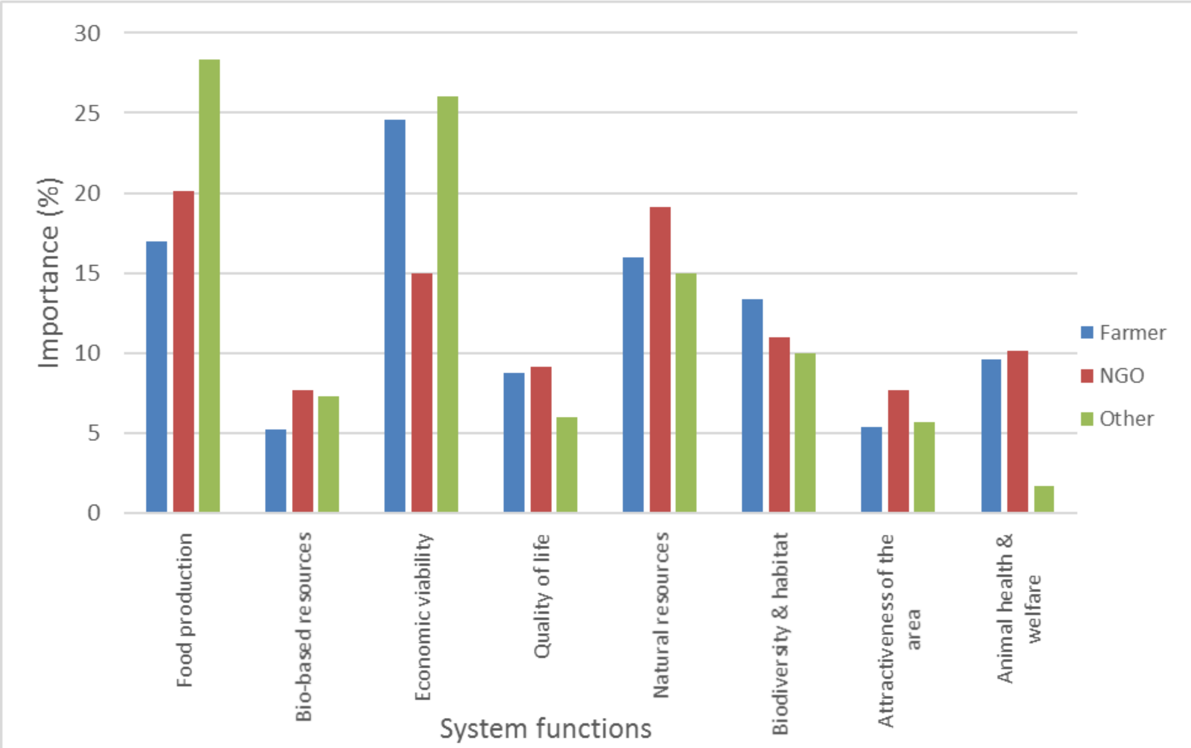


Figure 11.5. Bar chart with scoring per system function, per stakeholder group. 100 points needed to be divided over 8 functions.

Table 11.4. Mean and standard deviation of scores per function per stakeholder group and for all participants. 100 points needed to be divided to 8 functions.

	Farmer		NGO		Other		Grand Total	
Function	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Food production	17	6	20	6	28	13	21	8
Bio-based resources	5	4	8	5	7	7	7	5
Economic viability	25	21	15	6	26	5	20	13
Quality of life	9	5	9	3	6	4	8	4
Natural resources	16	4	19	8	15	5	17	6
Biodiversity & habitat	13	7	11	3	10	0	12	4
Attractiveness of the area	5	4	8	4	6	4	7	4
Animal health & welfare	10	7	10	3	2	2	8	6

Regarding the performance of the various functions in the farming system, the results of the FoPIA analysis shows that the performance of most indicators lies on average around a medium performance to slightly lower (Figure 11.6 and Table 11.5). This seems to fit with the stakeholders' views on the matter as in most cases they argued that no indictor performs very poorly, but there is significant room for improvement. As can also be seen in Table 11.5, participants in the *Others* group tended to give a higher performance score on most indicators than the other stakeholder groups, except when looking at the indicators for the “attractiveness of the area” and the “animal health & welfare” functions. *NGOs* rated a lower performance on the indicators for the “bio-based resources” and the “economic viability” functions, and for “the income level for agricultural workers” indicator. This opposes the *Farmers’* opinion, whom in this case followed the trend of the *Others*. For the other indicators, farmers and *NGOs* did agree on their performance.

The lowest performing indicator is the “share of farms that are owned/tenanted” because stakeholders disagreed with the use of this indicator (as they argued that corporate structure does not affect viability) which resulted in several stakeholders not scoring it. The “diversity of production” received a low score, as well as many stakeholders agreeing that in this large-scale arable system few choose to grow many different crops. The highest scoring indicators are the “extent of public access” as a result of the roads and rail links connecting the region with the rest of the UK and the “market share of products with certified higher levels of animal welfare” as in the UK the required level of health and welfare for animals is already high.

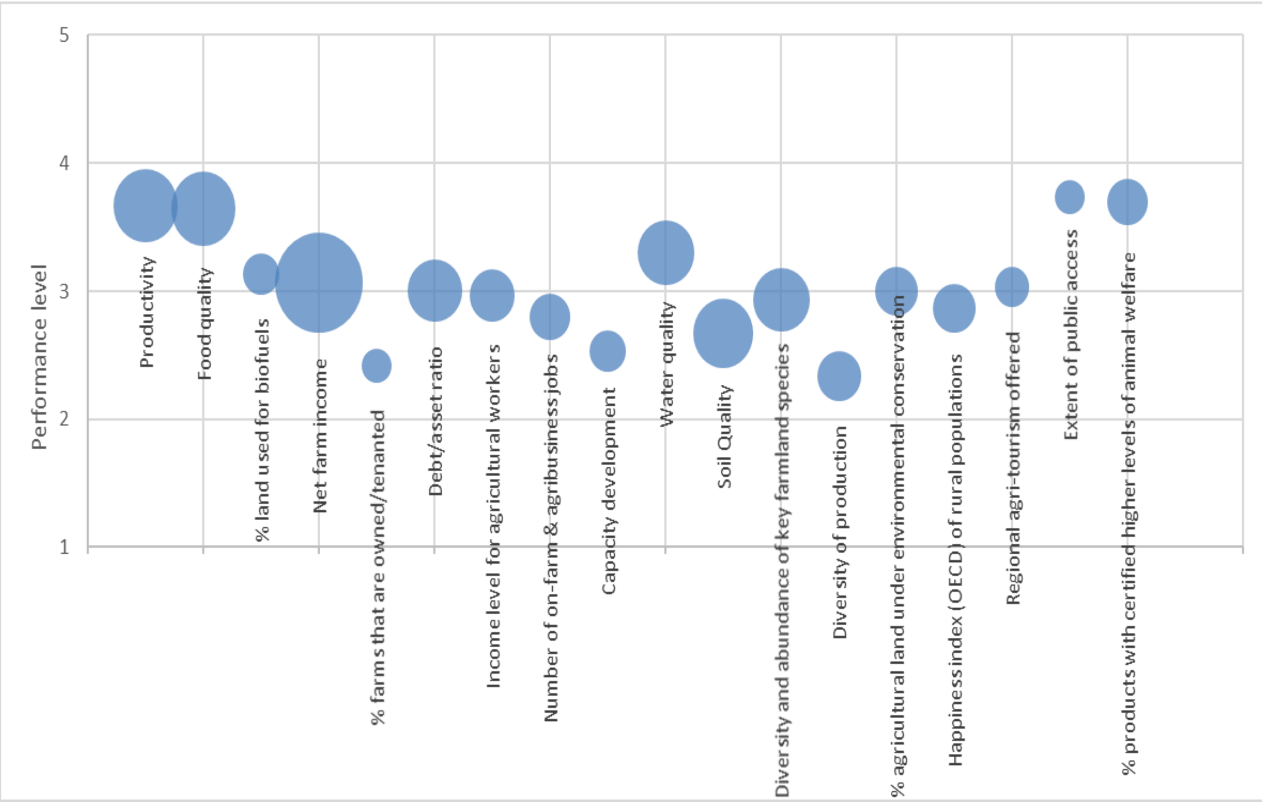


Figure 11.6. Bubble graph presenting averaged scores on performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.

Table 11.5. Mean and standard deviation of scoring on performance of indicators per stakeholder group and for all participants. Indicators were scored from 1-5 where 1 = very low, 2 = low, 3 = medium, 4 = good, and 5 = perfect; with colored ranges: 1-2 = red, 2-3 = orange, 3-4 = light green and 4-5 = dark green.

	Values							
	Farmer		NGO		Other		Grand Total	
Indicator	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Productivity (e.g. ton/ha)	3.600	0.548	3.429	0.535	4.333	0.577	3.667	0.617
Food quality (e.g. % under certification schemes)	3.400	0.548	3.714	0.756	4.000	0.000	3.643	0.633
% land used for biofuels	3.600	1.673	2.571	0.787	3.667	1.528	3.133	1.302
Net farm income	3.400	0.894	2.714	0.488	3.333	1.528	3.067	0.884
% farms that are owned/tenanted	3.000	0.816	2.000	0.894	2.500	0.707	2.417	0.900
Debt/asset ratio	3.250	1.708	2.667	0.816	3.500	0.707	3.000	1.128
Income level for agricultural workers	3.100	0.742	2.571	0.535	3.667	0.577	2.967	0.719
Number of on-farm & agribusiness jobs (e.g. working units/ha)	2.600	1.140	2.571	0.535	3.667	1.155	2.800	0.941
Capacity development (trainings and opportunities for workers)	2.200	1.304	2.429	1.134	3.333	0.577	2.533	1.125
Water quality (e.g. pesticides and nitrates in rivers)	2.900	0.894	3.286	1.113	4.000	1.000	3.300	1.032
Soil Quality (e.g. erosion, stability, …)	2.600	0.894	2.571	0.976	3.000	0.000	2.667	0.816
Diversity and abundance of key farmland animal, plant and insect species (e.g. birds, butterflies, meadow plants)	2.600	0.548	2.857	1.069	3.667	1.528	2.933	1.033
Diversity of production	2.000	0.707	2.286	0.951	3.000	1.000	2.333	0.900
% agricultural land under environmental conservation	2.800	0.447	2.857	0.690	3.667	0.577	3.000	0.655
Happiness index (OECD) of rural populations	2.800	0.837	3.143	0.378	2.333	1.155	2.867	0.743
Regional agri-tourism offered	3.100	0.742	3.000	0.816	3.000	1.000	3.033	0.767
Extent of public access (e.g. footpaths, bridleways etc.)	4.000	0.707	3.857	0.690	3.000	1.000	3.733	0.799
Market share of products with certified higher levels of animal welfare	3.700	0.447	3.857	0.690	3.333	1.155	3.700	0.702

For private goods, the ecosystem services (ES) assessment calculated the performance of *food crop production* as low (~0.26 – on a scale of 0 to 1) compared to other EU regions (Figure 11.7 - overleaf). *Fodder crop production* is also low (~0.35), while *grazing livestock density* and *timber removal* are extremely low (<0.1). Energy crop production is the only ecosystem private ecosystem service that receives a high performance score (~0.85).

Regarding public goods (Figure 11.8 - overleaf), only the *capacity to avoid soil erosion* scored highly (~0.85). The performance of the *water retention index* ecosystem service was moderate (~0.5), while *habitat quality based on common birds* received a moderate to low score (~0.4). The performance of all the other public ecosystem services was calculated as being very low or extremely low.

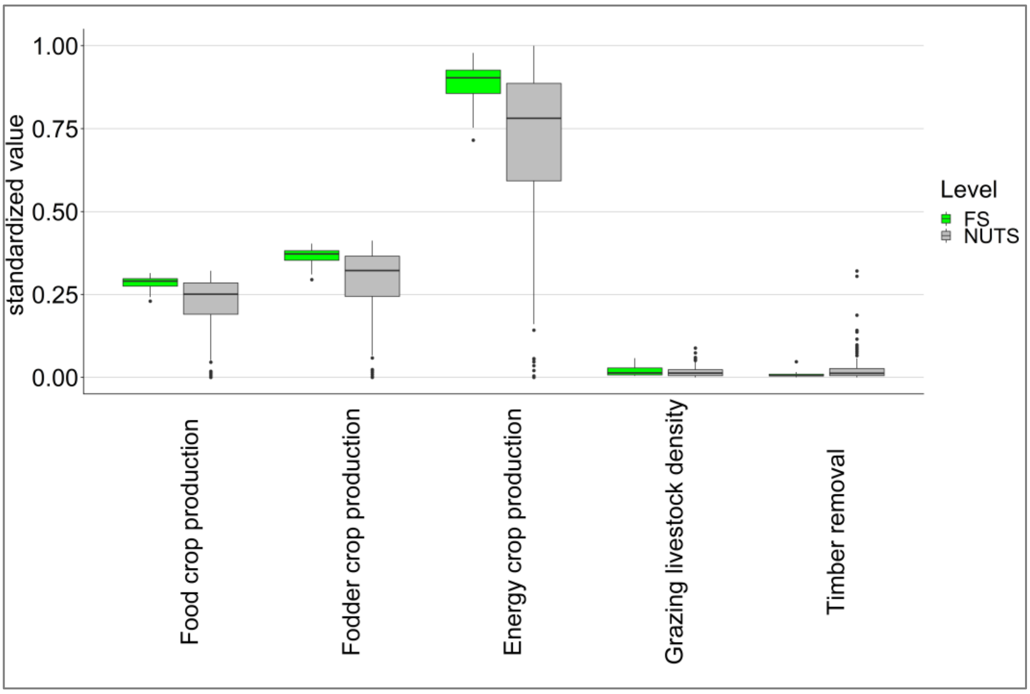


Figure 11.7. Performance of private goods in the farming system, calculated by the ecosystems services assessment

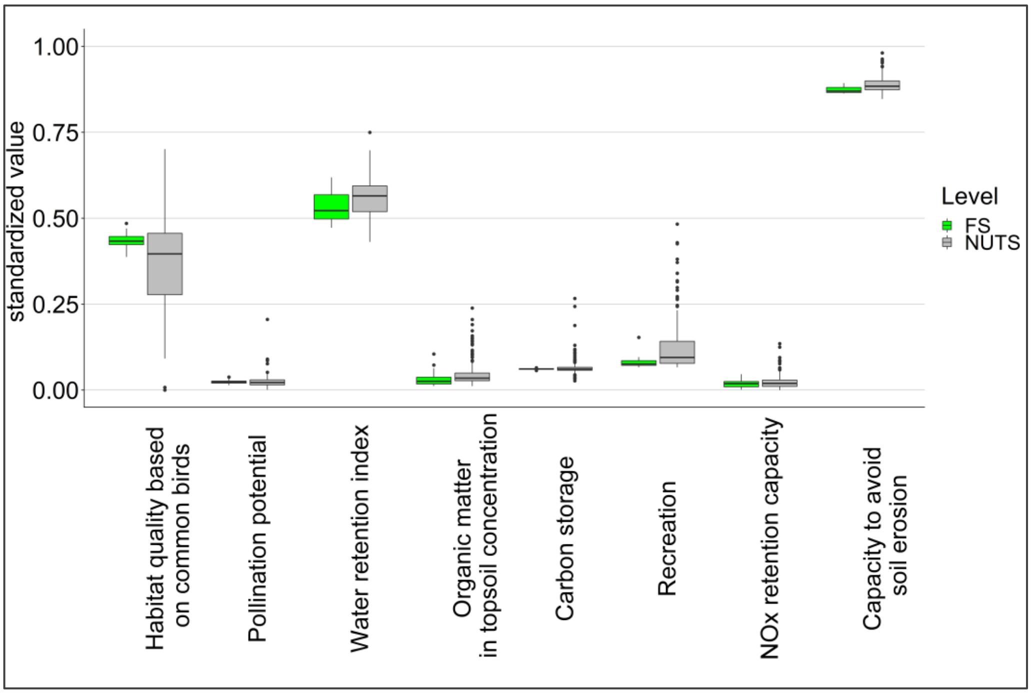


Figure 11.8. Current performance of ecosystem services related to public goods according to the ES assessment.

When analyzing the results of the ES assessment in the regional context, several discrepancies can be identified:

<u>Private goods</u>

- The very high performance score for *energy crop production* (~0.85) is probably reflecting a potential situation rather than an actual one, as currently the majority of crops in the CS region are produced for food and feed.

Public goods

- *Equilibrium Phosphorus concentration* received a very low performance score (~0.10), but if this is an indicator of water quality, then it should be higher as stakeholders believe water quality in the CS region is quite good.
- In terms of *carbon storage* (scored very low <0.01), the content of organic matter can be rather low in the region as the intensive production practices tend to deplete the organic matter of soils. However, at the farming level the content of organic matter could be slightly higher as many farmers adopt conservation agricultural practices (e.g. no-till) which receive greening subsidies and improve carbon sequestration.
- A higher score for *recreation* (~0.05) would have been expected as recreational activities (especially linked to agri-tourism) are among the key diversification strategies for risk management in the region. This was highlighted in the results of the farmer survey.
- *Capacity to avoid soil erosion* (~0.85) - On the one hand, intensive arable farming exposes soils to high erosion due to intensive tillage. Moreover, the frequent climatic risks (floods, etc.) further exacerbate erosion. However, conservation agriculture and cover crops are increasingly used, which might have a beneficial effect against soil erosion.

11.6 RESILIENCE CAPACITIES

11.6.1 Farmers and farm households

At farm level, adaptability scored highest on average, with 4.82, but scores for robustness (4.12) and transformability (4.29) were not statistically different. The learning and demographic interviews provided examples of robustness, adaptability and transformation at the farm level. Structural change on the farm is often a resilience strategy, enabling the farm to persist, adapt or even transform. It is often in response to an influencing factor such as policy change (e.g. regulation), access to labor, reduced profitability and a need to become more efficient. Negative drivers or shocks can also precipitate structural change. The pressures and challenges of farming, for example, can lead to physical and mental health issues, which in turn can lead to further structural or demographic change on the farm. Examples of changes and strategies in relation to the different resilience capacities at the farm level include:

- *Robustness* - Non-agricultural diversification is a common strategy adopted by arable farms in the East of England, which can enhance the robustness (and also demonstrates adaptability) of a farm business by spreading risk. Many arable farms have expanded their size as a resilience strategy, to enable better use of machinery, and to spread the risk across a larger geographical area (e.g. if a crop fails in one part of the farm, it may be ok elsewhere), thereby increasing the robustness of the business. There were also numerous examples of farmers cooperating with each other (e.g. sharing equipment or forming a cooperative or buying group) which is a risk management strategy that increase robustness, but also links to adaptability.

- *Adaptability* – Farmers appeared to have a high capacity to adapt, which was reflected in, and related to, their willingness to learn about new approaches, seek out information and engage in networks and knowledge transfer initiative, which can lead to structural changes in the farm business. Changes in the type of crops grown or cultivation method enable farmers to adapt to anticipating future regulations, such as restrictions on the use of plant protection products etc., and a move away from less labor-intensive forms of farming enables farmers to adapt to a reduction in the availability of good labor. In terms of barriers to adaptability, fear of change can hold back farms from adapting. This can be the case with older farmers, who are reluctant to change and prefer to stick with what they know. Farmers with lower debt are likely to be more resilient and able to persist despite shocks, and may be able to better adapt to stresses.
- *Transformability* – The learning and demographic interviews revealed evidence of transformative change on farms. For example, one farmer transformed a struggling dairy and livestock business by selling the dairy cows and converting the cowsheds to an equestrian center when he took over management of the farm. Factors that may impede transformation include emotional attachments to farming, where farmers who strongly identify with a certain type of farming/specialization may be less inclined to adapt or transform. Attachments to a certain specialization can influence decisions to persist even when it is no longer financially viable and/or the work becomes so hard it impacts on farmer wellbeing.

A significant overarching factor in determining the scale and pace of changes on farms necessary to increase resilience capacities in the UK at this time is, of course, Brexit. Until the future outcomes of Brexit and the details of the new post-Brexit agricultural policy are known, some farmers will be adopting a more risk averse stance and may be less likely to adapt or transform. Conversely, there is some evidence to suggest that other farmers are choosing to invest in large machinery upgrades while they still have the Single Farm Payment. The loss of the Single Farm Payment and a move towards public money for public goods is likely to result in more conservation farming, or a shift from food production to the provision of environmental services, which would suggest that many farm businesses will need to transform and adapt. For those not already involved in conservation farming, this could mean either adapting their production processes to the new policy, diversifying into non-agricultural environmental services, or exiting farming.

11.6.2 Farming system

An assessment of the farming system's resilience capacities was made according to the sketches of historical dynamics by stakeholders in FoPIA-SURE-Farm. The analysis of the strategies applied in the past (Figure 11.9 - overleaf) can give an insight in the past resilience of the farming system and suggest that the farming system was mainly robust. The level of robustness was closely followed by the level of adaptability meaning that the system's resilience was also due to its ability to adapt to new situations created by challenges. The lowest resilience capacity was transformability, meaning that the system lacked in flexibility allowing stakeholders to transform. While the system showed a higher robustness and adaptability compared to transformability, this study showed that the arable farming system had a low resilience overall.

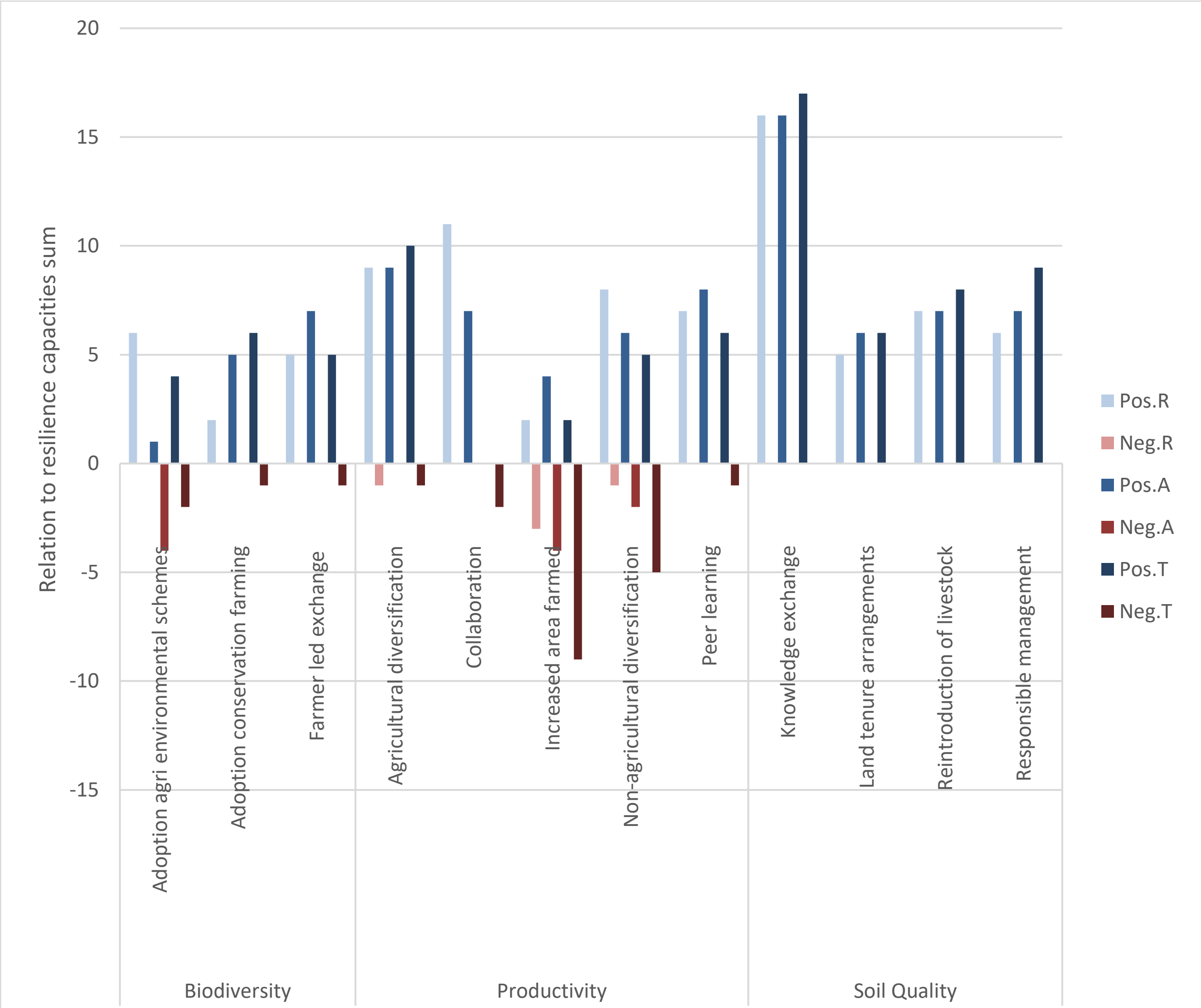


Figure 11.9. Strategies applied to cope with challenges affecting the indicators 'biodiversity', 'productivity' and 'soil quality', and their perceived contribution to the three resilience capacities according to stakeholders participating in the FoPIA-SURE-Farm workshop.

The current resilience of the system was further investigated through the general resilience attributes and estimating their implementation and contribution to the resilience capacities (Figure 11.10 - overleaf).

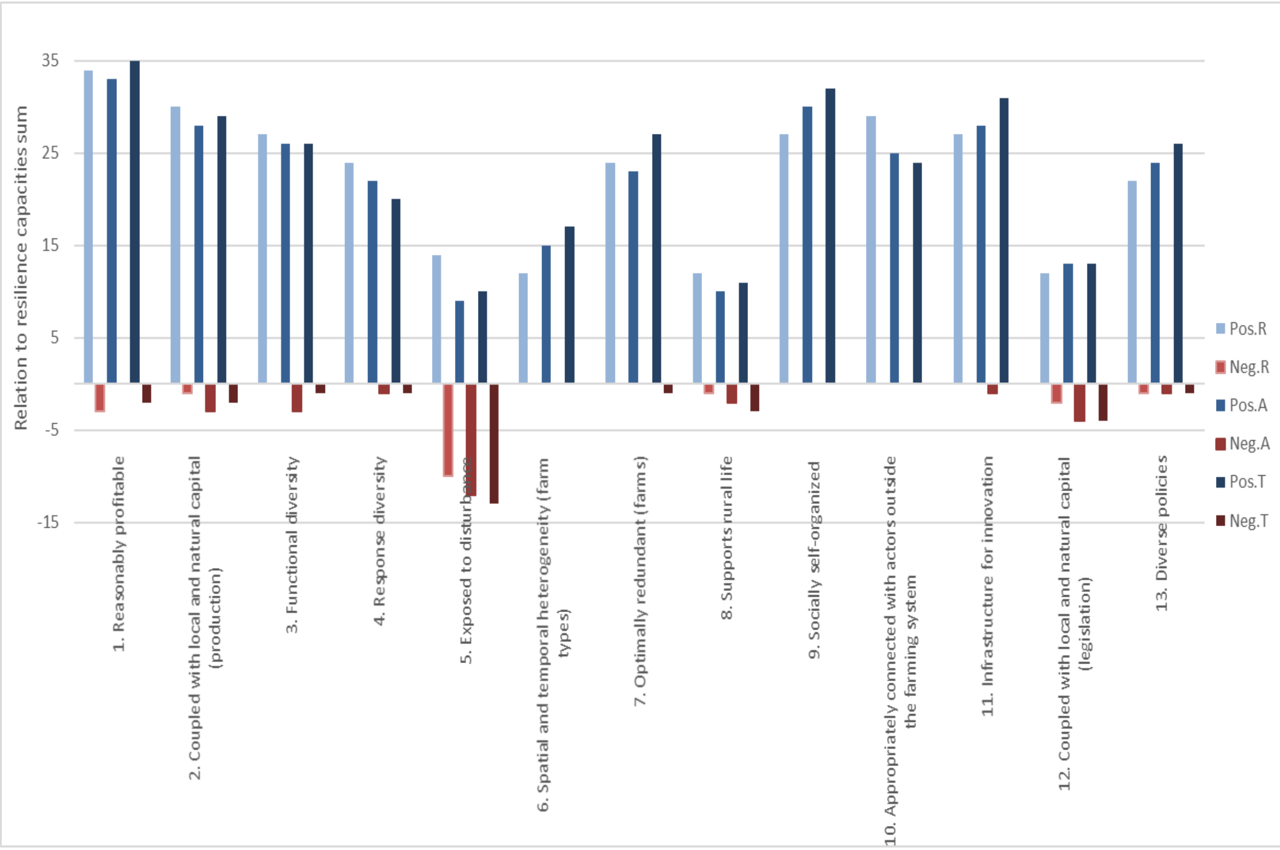


Figure 11.10. The contribution of 13 selected resilience attributes to 3 resilience capacities, according to the stakeholders in FoPIA-SURE-Farm workshop

The identified strategies linked mostly with the following attributes: “socially self-organized”, “functional diversity”, “coupled with local and natural capital (production and legislation)” and “spatial and temporal heterogeneity (farm types)”. The scoring of the attributes themselves can give an insight in the present resilience of the system. It showed that most general resilience attributes have a relatively high positive synergetic effect on the three resilience capacities for this farming system. The effect also seems to be evenly distributed across all three resilience capacities, leading to the conclusion that there is a relatively high potential for the increase of resilience, combined with the low performance of the attributes. The low performance, however, indicates that the farming system’s current resilience is low overall. The most important attributes for the system can be identified by considering the product of their performance, combined with their effect on the resilience capacities, to create a weighted importance. The most important general resilience attributes of the system are: “reasonably profitable”, “coupled with local and natural capital (production)”, “socially self-organized”, “appropriately connected with actors outside the farming system” and “infrastructure for innovation”.

The low scores of the resilience attributes mean that the current resilience of the system is fairly low. However, current resilience seems to be well balanced across robustness, adaptability and transformability. It is mostly a consequence of the actors in the system being able to make a livelihood and save money, while functioning as much as possible on available natural resources. These actors are also able to create and reconfigure social interactions based on their needs, while also connecting with actors outside of the farming system and with organizational infrastructure that facilitates diffusion of knowledge and technologies.

11.6.3 Concluding remarks on resilience capacities

The farming system seems more robust than adaptable and transformable, although the overall resilience of the system is low, based on the low scores attributed to the resilience attributes. The main strategies implemented in the past contributed most to robustness. However, some strategies applied (in relation to knowledge exchange and collaboration) contribute also to adaptability and transformability. Stakeholders also perceived the contribution of resilience attributes highest for robustness, followed by adaptability and then transformability.

At the farm level, adaptability seems stronger than robustness or transformability. It may be that the farmers view their own capacity to adapt and transform as being higher than the capacity of others in the farming system. The difference may however also be due to differences in methodology; questions in the farm survey were more direct.

11.7 RESILIENCE ATTRIBUTES

11.7.1 Farmers and farm households

Using the results of the farmer survey and learning and demographic interviews, an assessment of resilience attributes at the farm and household can be made. The 13 individual resilience attributes identified by the SURE-Farm consortium were mapped to the five generic resilience principles, and these principles are used to summarize the findings.

- *Diversity* – Arable farmers in the East of England connect with various forms of diversity. These include for example engaging in non-agricultural activities on the farms such as agri-tourism, biofuel or renewable energy production, and reusing farm buildings for other purposes such as horse stabling or office lets. Looking to the future, and Brexit, the resulting removal of the single farm payment and a new policy of public money for public goods is likely to result in farm structural change, including an increase in conservation farming or diversification activities. Also, farmers engage in a diverse range of risk management strategies and there were many examples of cooperation between farmers. Although diversification is seen as improving farm resilience, there are barriers to some forms of diversification, such as obtaining planning permission and objections from the local community. Additionally, certain farms may be better suited to some forms of diversification that others, due to their geographical location, farm characteristics, and availability of farm buildings.
- *Openness and modularity* – Learning from others about novel agricultural practices, and encouraging learning, flexibility and openness to new ideas can be regarded as attributes of openness and modularity. Many of the farmers interviewed engaged in a range of learning activities (such as talking to farming neighbors, engaging in discussion groups, observing what

other farmers are doing and seeking out advice from other farmers) and had diverse networks of influence. Experimentation was also an important learning strategy, with farmers trying out new things on their farm and seeing how they worked. This was often done a little at a time, in combination with learning about the new approach through seeking out information and talking to other farmers. Experimentation may occur both in terms of agricultural production, but also for diversification activities. Respondents also spoke about the need to be open to new ideas, and to be flexible and reflexive.

- *Tightness of feedback* – The flow of information in the farming system provides an interesting example of feedback opportunities and barriers. While the use of new communication technology in the form of social media is improving the flow of information from knowledge producers to learners, farmers highlighted issues concerning the flow of knowledge from education/policy/research institutions – with information often slow to emerge, or presented in such a way that made it difficult to understand and interpret (i.e. too technical/scientific). Engaging in networks and exploring collaboration are ways in which this could be improved.
- *System reserves* – In terms of economic capital as a system reserve, there are varying attitudes to financial risk amongst farmers - age seems to be an important factor, with younger farmers less risk averse and perhaps more likely to take on debt. Farmers with lower debt are likely to be more resilient and be able to persists despite shocks. Farmers with high levels of debt are constantly focused on paying off the debt, though a willingness to invest in technology can help to improve efficiency. Regarding the critical issue of labour supply, it could be argued that the system reserve is low – when older farm workers retire it can be difficult to replace them with committed and skilled workers, and there are a host of economic and social barriers preventing the younger generation from being attracted to farming.

11.7.2 Farming system

During the final part of the FoPIA workshop, stakeholders examined 12 resilience attributes and scored their performance and contribution to the robustness, adaptability and transformability of the farming system (Figure 11.11). This provided insights on the current resilience of the farming system. Results indicate that the current resilience is low resulting from a low performance of the resilience attributes, with an even contribution to the robustness, adaptability and transformability of the system.

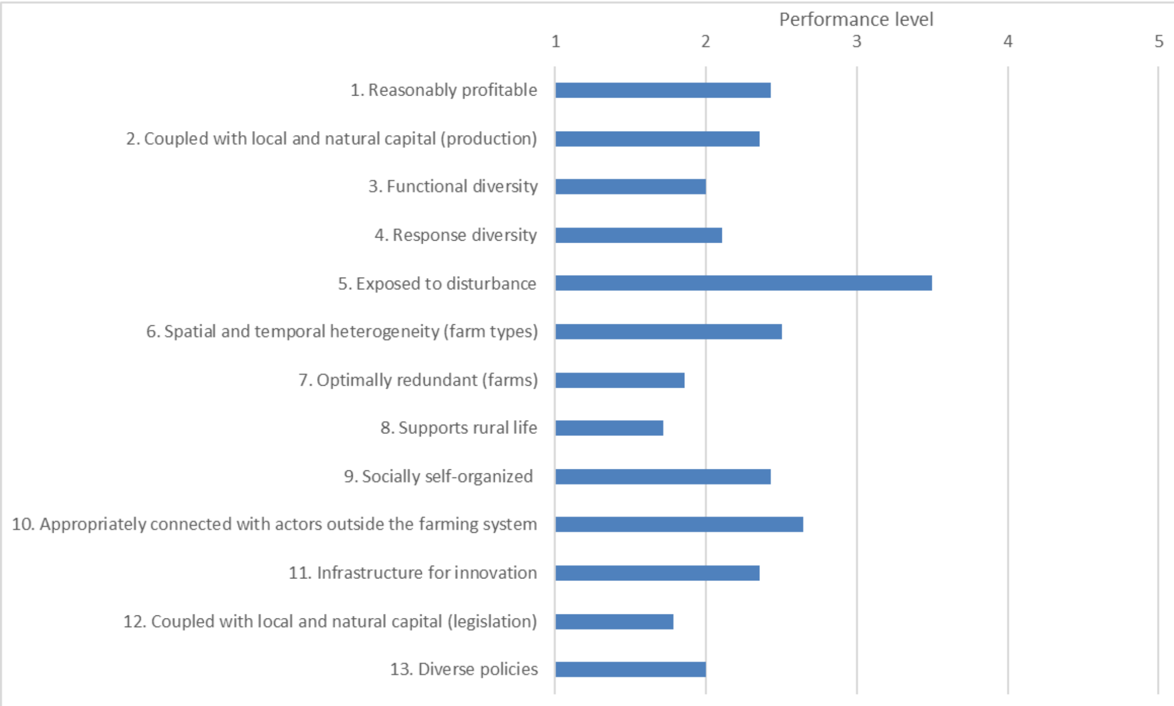


Figure 11.11. Bar graph showing current performance level of resilience attributes. Performance is scored as 1 = not at all applied, 2 = somewhat applied, 3 = moderately applied, 4 = much applied, 5 = very much applied.

The highest scoring attributes had low to moderate performances, namely:

- Reasonably profitable (2.4)
- Coupled with local and natural capital (production) (2.4)
- Spatial and temporal heterogeneity farm types (2.5)
- Socially self-organized (2.4)
- Appropriately connected with actors outside the farming system (2.6)
- Infrastructure for innovation (2.4)

The lowest scoring attributes, with a mean score lower than 2 (somewhat applied) were:

- Optimally redundant (farms) (1.9)
- Supports rural life (1.7)
- Coupled with local and natural capital (legislation) (1.8)

The attributes for which there was the most disagreement on their performance in the farming system, based on the standard deviations (Table 11.6), are also attributes that were among the highest or lowest scores. These included: "optimally redundant farms", "socially self-organized" and "appropriately connected with actors outside the farming system".

Table 11.6. Mean and standard deviation of performance scores of resilience attributes. Per stakeholder group and for all participants.

	Extent into which attribute applies in FS							
	Farmer		NGO		Other		Grand Total	
Resilience attribute	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
1. Reasonably profitable	2.2	0.8	2.3	0.5	3.5	2.1	2.4	0.9
2. Coupled with local and natural capital (production)	2.3	0.5	2.3	0.8	2.5	0.7	2.4	0.6
3. Functional diversity	1.8	0.4	2.0	0.9	2.5	0.7	2.0	0.7
4. Response diversity	2.3	0.4	2.0	0.0	2.0	0.0	2.1	0.3
5. Exposed to disturbance	4.0	1.1	3.5	1.4	2.0	0.0	3.5	1.3
6. Spatial and temporal heterogeneity (farm types)	2.2	0.4	2.7	0.8	3.0	1.4	2.5	0.8
7. Optimally redundant (farms)	1.5	0.8	1.8	1.2	3.0	1.4	1.9	1.1
8. Supports rural life	1.7	0.8	1.5	0.5	2.5	2.1	1.7	0.9
9. Socially self-organised	2.3	1.0	2.3	0.8	3.0	2.8	2.4	1.2
10. Appropriately connected with actors outside the farming system	2.7	1.2	2.7	1.0	2.5	2.1	2.6	1.2
11. Infrastructure for innovation	2.3	0.8	2.2	0.4	3.0	0.0	2.4	0.6
12. Coupled with local and natural capital (legislation)	1.8	0.8	1.5	0.5	2.5	0.7	1.8	0.7
13. Diverse policies	2.2	1.2	2.0	0.0	1.5	0.7	2.0	0.8

The resilience attributes for the farming system have also been linked to five general resilience principles, allowing the performance of the general resilience principles for the East of England using the performance of the attributes:

a) ***Diversity***: as a result of being linked to attributes 3, 4, 6 and 12 the “diversity” resilience principle would score a performance of approx. 2.2 (between *somewhat applied to moderately applied)*.
b) ***Modularity***: as a result of being linked to attributes 6 and 7 the “modularity” resilience principle would score a performance of approx. 2.2 (between *somewhat applied to moderately applied*)
c) ***Openness***: as a result of being linked to attributes 5 and 11 the “openness” resilience principle would score a performance of around 2.4 (between *somewhat applied to moderately applied*).
d) ***System reserves***: as a result of being linked to attributes 1, 2, 8, 11 and 12 the “system reserves” resilience principle would score a performance of about 2.1 (*somewhat applied*).
e) ***Tightness of feedback***: as a result of being linked to attributes 6 and 7 the “tightness of feedback” resilience principle would score a performance of about 2.5 (*between somewhat applied to moderately applied*).

The scores indicate that the resilience of the system would mainly come from the openness of the system and the tightness of feedback within the system. However, in keeping with the findings of other SURE-Farm research activities, all the resilience principles score relatively low. This means that there is room for improvement and development for all five principles with most development potential on the three with the lowest score, namely: "diversity", "modularity" and "system reserves".

When looking at Figure 11.12 (overleaf) which shows the mean contribution of the resilience attributes to the three resilience capacities, it can be noticed that there is little variety in the relative contribution from one capacity to the other. Besides contributing to robustness, adaptability and transformability in a relatively uniform way, it is also apparent that the mean contribution of all the attributes is positive. The largest difference in contribution comes from the "being socially self-organized" attribute. This attribute has the lowest standard deviations together with the "spatial and temporal heterogeneity" attribute.

As a result of the uniform distribution of the scores between the three resilience capacities, it can be concluded that there is a general synergy and no trade-offs between robustness, adaptability and transformability. The only trade-off happens when choosing which attributes to develop, e.g. if one had to choose between "reasonably profitable" and "supports rural life" there is a trade-off between the amount of contribution to resilience.

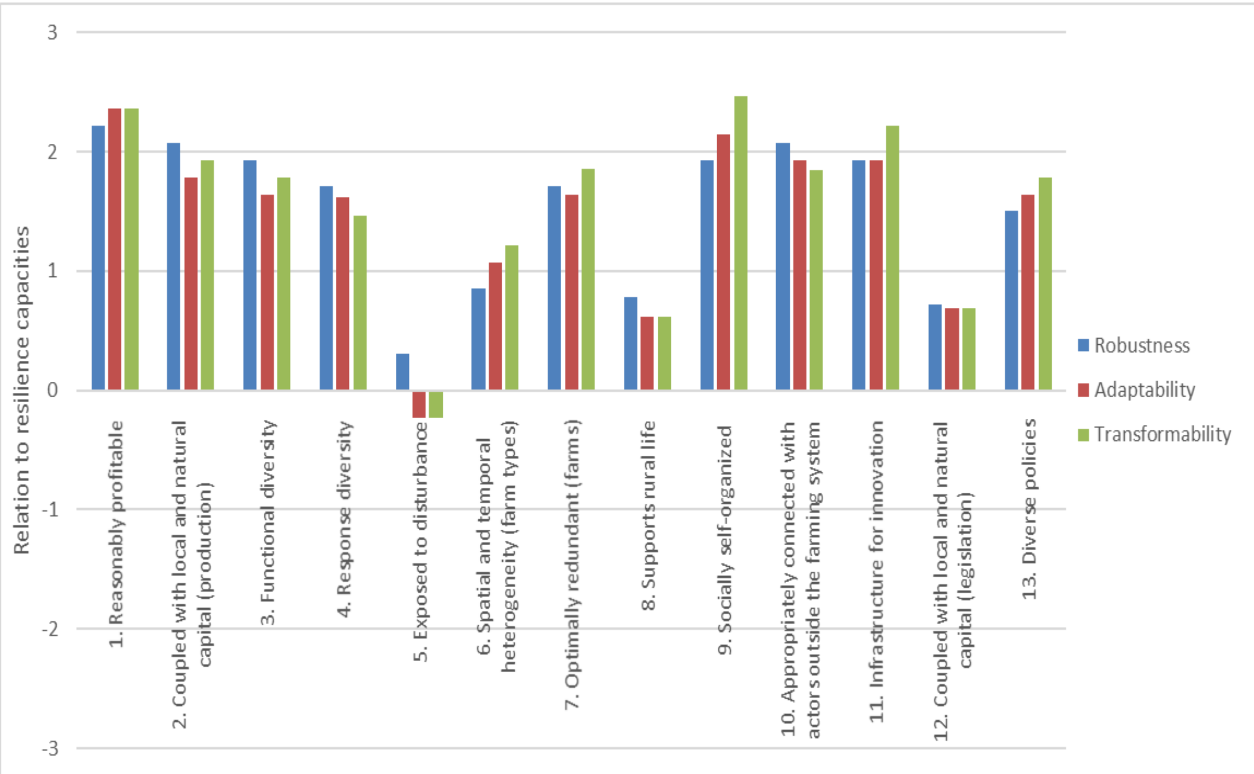


Figure 11.12. Bar graph showing average scoring of perceived effect of attribute on robustness, adaptability and transformability. A 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship

The combined interpretation of the performance and the contribution to the resilience capacities of the attributes provides information on the current general resilience of the farming system. In this case, the low average performance of the attributes benefits from the overall positive contribution to the capacities. In other words, although there is much room for improvement for the performance, according to the stakeholders they all improve the robustness, adaptability and the transformability of the system. Additionally, any improvement of the performance of the attributes is perceived to considerably improve the general resilience of the system as it becomes more robust, adaptable and transformable at the same time. The main exception to this would be the "exposed to disturbance" attribute as it already is at high performance and when it changes, stakeholders perceive little (positive for robustness, negative for the other capacities) to no effect on the robustness, adaptability and the transformability of the system. For the other attributes there are three arguments that indicate that the higher the performance of the attribute the higher the potential for increase of the system's resilience:

1. All have a relatively low performance and could increase,
2. All have a positive contribution to the three resilience capacities,
3. Higher performing attributes have higher contribution to resilience which means that the same amount of increased performance has more effect.

11.7.3 Concluding remarks on attributes

The current resilience of the East of England arable farming system seems to be low based on the performance of the resilience attributes. The general positive effect on the resilience capacities of the attributes provides the system with a high resilience potential, which would be balanced equally over the three capacities, consolidating that potential. However, as the performance is low, there is a clear need to increase it to be able to be resilient to coming challenges. It would be advised to invest in the performance enhancement of the resilience attributes, starting with those most cost effective or those most suited to recover from challenges expected to cause disruption. It could be argued that resilience attributes perform better at the farm and household level, where there appears to be a higher level of openness, diversity etc. A summary of resilience attributes across all methods is shown in Table 11.7 (overleaf).

Table 11.7. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Non-agricultural diversification (RM, G)	Low functional diversity (e.g. reducing chemical inputs) (AP, RM) Low response diversity (flexible payments with merchants possible but reducing availability of chemicals is a problem) (RM) Lack of diverse policies (G)	Non-agricultural diversification (RM, AP) Risk management strategies and cooperation between farmers (RM, AP)	Obtaining planning permission and objections from the local community (G) Geographical factors, access to markets (G) Brexit hindering decision-making (G)
Openness	Learning, engaging with agri networks and actors outside the farming system (RM, G)	Public perception and social media opposition to farmers (G) Infrastructure for innovation: knowledge is available, but farmers do not follow advice (RM, G)	Learning from others. Experimentation and openness to change (RM, AP)	Resistance to /fear of change (RM)
Tightness of feedbacks	Engaging in networks, exploring collaboration (G, RM)	Slow/unclear communication of information/knowledge (G)	Engaging in networks, exploring collaboration (G, RM) Succession is a big problem, which is very emotional and brings high risk (FD)	Slow/unclear communication of information/knowledge (G)
System reserves	Profitability (AP, RM) Moderate level of infrastructure for innovation (AP, G)	Production is weakly coupled with local and natural capital (AP) Profitability is low to moderate (AP) Unsustainable labour supply (FD)	Debt management/ low debt (RM) Labour supply (G, FD, AP)	Training and policies around agricultural labour force (G) Succession (FD)
Modularity	Learning, collaborating, experimenting (AP, RM)	Low spatial and temporal heterogeneity (most of EoE heavily arable) (FP, G) Lack of policy instruments on learning and knowledge (G)	Learning, collaborating, experimenting (AP, RM)	Non-engagement in networks (RM)

11.8 ADAPTIVE CYCLE

Given the position of the separate process on the adaptive cycle (i.e. risk management, governance, farm demographics, agricultural production) the arable farming system of the East of England currently seems to be in the conservation phase of the adaptive cycle (Figure 11.13). This is mainly because the arable farming system in the East of England has remained fairly static over recent decades, with little change. It is buffered to some degree by single farm payments, which have enabled farmers to weather fluctuations in grain prices. However, a significant change in this position is possible soon, and depending on the outcomes of Brexit, the system may swiftly enter a period of reorganization, or even collapse if the UK undergoes a "disorderly" exit from the EU which impacts negatively on the system (in the short term at least).

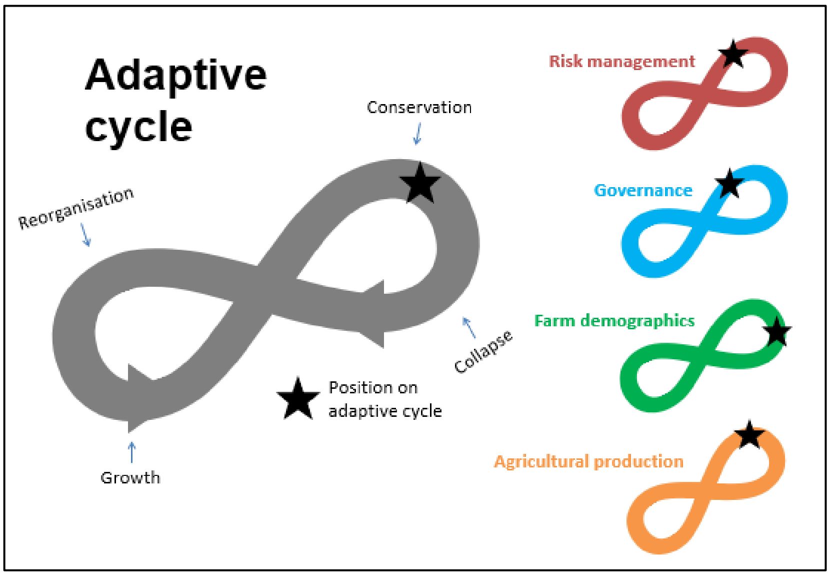


Figure 11.13. Positioning the East of England arable farming system on the adaptive cycle of processes in agriculture.

With regard to the separate processes:

- *Agricultural production* – There are efficiencies to be made in terms of agricultural production, by, for example, farmers investing in new technologies. Recent figures on the total factor productivity (TFP) of the UK agriculture industry (DEFRA, 2019) indicate a short-term (2017-2018) fall in TFP in the arable sector (including cereals) though the long-term trend shows a sustained increase in productivity since the 1970s. A possible move to a more conservation-farming based system after Brexit may significantly alter the position of agricultural production on the adaptive cycle; we could see the sector going into the *collapse* phase followed by a period of *reorientation*.
- *Governance* – The general focus has been on maintaining the status quo, though agricultural policy could be about to undergo a fundamental change and a wholesale reorganization in a post-Brexit UK. Findings from interviews and workshops suggests that there is significant scope for policy development, with enhanced agricultural, economic and planning policy tools and funding instruments required to improve the rural economy, drive farm business efficiencies and help farmers implement the structural business changes necessary for improving resilience across the different capacities (e.g. non-agricultural diversification).
- *Farm demographics* – This is a process that is arguably moving beyond the conservation phase and potentially nearing collapse. Chronic problems with the current supply of labor (particularly skilled labor as the job demands an increasingly complex set of skills) and issues

with attracting future workers into the farming industry mean that the sustainability of the arable farming workforce is a concern. Additionally, there is a reduction in access to foreign labor, which has been an important source of both skilled and unskilled labor. This issue is likely to intensify after Brexit and, along with a decline in the number of young British people wanting to farm, agricultural labor shortages are likely to continue.

- *Risk management* – The results of the risk management workshop suggest that there is room for improvement in risk management, with numerous new risk management strategies, and improvements to existing strategies, put forward by stakeholders as means of increasing resilience at a farm and system level.

11.9 STRATEGIES

Strategies for the future contain a variety of approaches for increasing the different resilience capacities. Given the current low resilience of the farming system and the potential for fundamental changes to its structure following the UK's withdrawal from the EU, strategies focusing on transformability to respond to such major changes may be more worthwhile in the long term. This is a view that would probably be supported by the stakeholders who participated in the risk management workshop – their opinion was that arable farmers in the East of England are good at coping with large-scale shocks and can respond well to 'tipping points', with many proven to be capable of transforming into other agricultural specializations in response to major triggers. However, participants suggested that farmers may have less ability to adapt to more minor changes, and small farms in particular have less ability to adapt, meaning that often the intermediate "adaptability" step can be missed. The learning interviews revealed different learning types: *proactive* and *reactive* learners – with proactive learning occurring for robustness, adaptability and transformation and where reactive learners were less able to adapt – they may transform, but this is likely due to reach a trigger point when they can no longer function as they did before. Strategies for improving resilience and managing risk gleaned from the various research activities are summarized in Table 11.8.

Table 11.8. Future resilience strategies per process

Process	Future strategies
Agricultural production	- New technologies - Agricultural/ crop diversification - Less stringent regulation on chemicals/gene editing - Improved engagement with knowledge/research networks - Learn from other farming systems (e.g. dairy) in terms of vertical integration - Create opportunities for increasing understanding of technology - More collaborative approach to science – co-production of science/knowledge (i.e. farmers working more closely with researchers as partners) - Adoption of conservation farming - Peer learning
Farm demographics	- More effective succession planning (and supporting policies)
Labor	- National school learning curriculums developed so that agriculture given more status - from primary through to further education - More closely connect schools with sector - Develop a GCSE qualification in agriculture/food production - Integrating work on education being done by NFU, supermarkets, agricultural societies etc. and feeding into school education - Improve public perception of farming
Farm management	- Cooperation between farmers - Role for business advisors to fill the 'learning gap' to enable reactive farmers to better future-proof their farm business - Peer learning - More effective peer to peer learning via a facilitator (e.g. monitor farms) - Engagement with business advisors and improved advisory services - Improve farmer engagement in benchmarking - Develop a service provided by central government to influence efficiency (used to have this - Farm Business Advice Service) - Land tenure arrangements
Governance	- More policy certainty and resolution of/ clarity on new post-Brexit UK agricultural policy - Overcoming bureaucracy (e.g. agri-environment schemes) - Policy instruments to deal with price volatility - More long-termism and policies to encourage long-term planning - Decision-making based on science and better evidence - Developing policy toolkits which are fit for purpose - Developing a payments system based on outcomes/performance (e.g. results-based payments) - Improve public perception of/connection with agriculture - Improved national and local planning laws/framework - Tax laws and inheritance – ensuring greater consistency and certainty over time - Development of insurance policies to deal with shocks to the market (perhaps based around enforced saving for hard times) - More effective tariffs and improved and wider trade relations - Support to enable farmers to engage in networks/groups - Consistency in planning policies across local authorities - Requirement for planning practice guidance that considers agricultural diversity - Development of a joined-up national planning portal - More joined-up thinking in terms of rural development/sustainability strategy (across e.g. agriculture, health, education, environment etc.)
Risk management	- Increasing financial stability (e.g. low debt, increased savings) - Increase efficiency (e.g. reduce input costs, maximise profits) - Agricultural diversification (crops and/or livestock) - Non-agricultural diversification - Implementation of conservation and/or organic farming - Implement measures to prevent pests or diseases (e.g. strict hygiene rules, pest resistant varieties, new rotations) - Use of market and/or environmental information to inform business decisions - Engaging in learning and knowledge exchange - Stop farming - Off-farm employment income

11.10 CONCLUSION

Findings from the different studies examining the resilience of arable farming in the East of England suggest that overall, the current resilience of the system appears to be low, though there is evidence to suggest that resilience capacities are higher at the farm and household level than they are at the farming system level. There is clearly a need to improve the resilience of the system to meet the numerous current and future (both short-term and long-term) challenges identified through the different research activities. The potential for increasing resilience seems to be high, as there is evidence to suggest that resilience attributes (which are currently performing poorly in general) have a strong positive synergistic effect on all of the resilience capacities.

Regarding challenges, the imminent departure of the UK from the EU is clearly a huge issue which is linked in some way to most of the other challenges identified. Uncertainty about the post-Brexit agricultural policy in the UK and the loss of the single farm payment are major concerns for some farmers, though there are others that view the likely changes as a positive opportunity for arable farming in the East of England, particularly those farmers already engaged in conservation farming practices who might welcome a move to more environmentally-focused, performance-based government support for agriculture. Other important challenges facing farmers include dealing with fluctuating market and input prices, relegation of plant protection products, and current and future problems with labor supply.

The stakeholders who participated in the various research activities for the UK case study put forward a wide range of strategies for coping with current and future challenges (summarized in Table 8) faced by arable farming in the East of England – both at farm and household level, and farming system level. The ability of farmers and other stakeholders to implement these strategies, and the determination of which strategies will be the most pressing/important over different timescales, will depend to some extent on the future institutional and trading relationship with the EU. Arguably, it is the current uncertainty surrounding Brexit that is the greatest threat to the resilience of the farming system in the short term. Even when a future institutional and trading landscape for British agriculture is becomes clearer, it impossible to predict at this stage whether the farming system will continue to remain in the conservation phase of the adaptive cycle, or whether it will collapse and/or reorganize, and timescale(s) over which such changes may happen are also unknown. What is certain is that farmers will need to ensure that their businesses are robust enough to cope with sudden (and possibly major) institutional and market shocks that may arise in the coming months, while also being prepared to respond by adapting and possibly transforming their farms

12 CASE STUDY ITALY

Simone Severini, Federico Antonioli and Saverio Senni

12.1 ABSTRACT

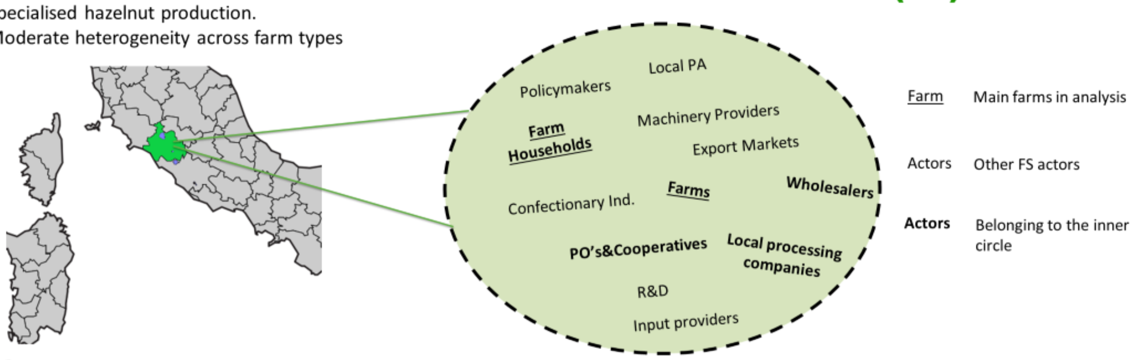
The farming system for the Italian case study is specialized hazelnut production located in the province of Viterbo, Centre-West Italy, within the Lazio region. The area is heavily devoted to the hazelnut production, gathering around 95% of the whole regional production.

Relying upon the resilience framework (see Meuwissen et al. 2019), the system is constituted by three main actors within the inner circle who show mutual dependence with farmers, namely wholesalers, producer organizations (POs) and cooperatives, and local processing companies. Other actors who affect farmers but are not affected by the latter are local public administrations (PA), policymakers (at various levels), machinery providers, export markets, confectionary industry, research centers and institutions, and input providers. Concerning the essential functions accomplished by the farming system, these are differentiated into two main categories, private-good functions (i.e., providing a sufficient income and high-quality products), showing a satisfactory and high performance, and public-good functions (i.e., preserving natural resources), depicting a quite low performance, especially because of the negative environmental impact of hazelnut production. Diverse challenges are characterizing the hazelnut sector, with a rising social conflict regarding the impact on the surrounding environment, and a growing concern over the downstream market power exerted by the industry, without excluding both environmental and institutional difficulties, especially related to the regional bureaucratic apparat that cause sluggishness of Pillar 2 related payments to farmers. Strategies mainly focused on increasing robustness (i.e., high profitability of the sector and high self-organization) at the detriment of adaptability and robustness. Diversification of activities and production, developing *ad-hoc* insurance instruments, enhancing Common Market Organization (CMO) operations, deepening the relationship with research centers and adopting new techniques and technologies are future and on-going strategies the farming system settled. The system's diversification is very low, not very well connected with outside networks, and lacking modern infrastructure. On the other hand, it exploits good self-organization levels with extended and working network among farms, relying upon large economic capitals, and off-farm incomes, since many are part-time farms. Concerning the adaptive cycles, the system as a whole is at a conservation phase, having to witness a growth phase in the recent past. When looking at different dimensions, risk management is re-organizing, trying to offer new ad-hoc instruments for the hazelnut sector, governance is at its conservation, whereas farm demographics is growing, as there is an ongoing positive generational renewal, and, hence, younger farmers are going towards a re-organization of the system in terms of agricultural production, introducing new ideas and principles. Figure 12.1 provides a synthesis of results of methods to assess current resilience of the hazelnut farming system.

Farming system

Viterbo (IT)

Specialised hazelnut production.
Moderate heterogeneity across farm types



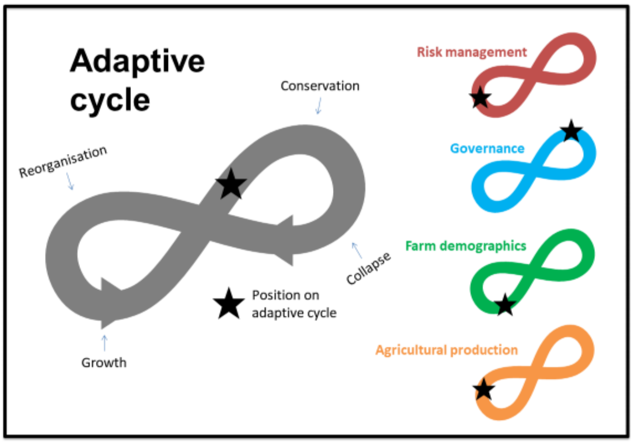
Challenges

Institutional:
- Delay in RDP policies;
- Introduction of stringent environmental local regulations;

Environmental:
- Water scarcity;
- Climate change (drought);
- New bugs;

Economic:
- Increasing international competition;
- High down-stream market power;
- Decline in prices;

Social:
- Societal conflicts (environment, health and landscape).



Essential functions

Private goods:
- Economic viability (sufficient income): *high performance*
- Food production (high quality product): *high performance*

Public goods:
- Negative environmental impact: *low performance*

Private goods dominate Public goods

Resilience attributes

Diversity: Low	⊘ Production specialization (high economic profits)
Modularity: Moderate to high	✓ Many part-time farms, incidence of off-farm income
System reserves: High	✓ Large economic capital
Tightness of feedbacks: Low to moderate	⊘ Low to none connection outside the farming system; ⇆ Self-organized, good network among farms, cooperatives
Openness: Low	⊘ Lack of modern infrastucture

Resilience capacities

Overall low to moderate resilience capacities

Mainly **R**obust (high profitability and self-organisation), low **A**daptability and **T**ransformability.

Current policy configuration enhance **A**daptability while raising concern for **R**obustness in the short-run.

Future strategies

Risk management
- Non-agricultural activities and product diversification
- *Ad-hoc* insurance instruments
- Credit institutions into rural areas
- Increase upstream bargaining power (coops&POs)

Governance
- Strenghtening demarcation of functions and policy goals between CMO and RD or shifting some RD measures to CMO operational programs

Farm demographics
- Cementing the relationship with research centres

Agricultural production
- New technologies&techniques
- Improved water management
- On-farm/On-PO processing for adding value

This project has received funds from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 727520

Figure 12.1. Factsheet synthesizing the current resilience of the hazelnut farming system in Viterbo, Italy.

12.2 FARMING SYSTEM

The Italian case study concerns the hazelnut sector in the province of Viterbo (EU NUTS3 code: ITI41)[12], belonging to the region of Lazio. Hence, the considered agricultural sector can be classified as a perennial crop, and the solely Viterbo's territory hosts 97% of both hazelnut surface and production of the entire Lazio region, the latter representing more than one-third of Italian production (ISTAT, 2019). On an overall population of more than 6,000 hazelnut farms, the lion share (i.e. 86%) is represented by agricultural units of less than 10 hectares, that is family and part-time farms (ISTAT, 2010).

Reasons for selecting this specific agricultural sector are multiples. On the one hand side, it generates a value-added of around 73 billion euros in the region, positioning as one of the most valuable agricultural productions on the national territory (CREA, 2017) and the presence of POs is highly significant. On the other hand, there is growing intensification and specialization on this valuable crop in the area, which has raised concerns. First, the market power exerted by downstream confectionary companies is significant and increasing, casting doubts on the fair redistribution of value-added. Second, there is growing concern about the possible negative impact this crop could cause on the environment. Several municipalities have adopted more stringent regulations limiting the use of chemicals as well as banning the implantation of new hazelnut trees in some municipalities of the case study region. These limitations have reduced the room of manoeuvre of producers and exacerbated debates on whether these additional constraints are indeed useful and justified on a scientific basis or not. Furthermore, other important challenges are found relative to climate change: water scarcity starts to be a serious issue for hazelnut growers, together with the increase of temperatures and irregular rains. Finally, the Halyomorpha halys (a bug coming from Asia and affecting the amount and quality of the product) could be a major problem for the future of hazelnut production in the area as it is already the case in several Asian countries (e.g. Georgia) and other areas in the north of Italy (Bosco et al., 2018). Note that the spread of this new bug could require a relevant increase in the use of chemicals. The abovementioned issues and challenges call for a deeper analysis and assessment of farming system's resilience, unveiling its ability to resist and respond to both short- and long-run shocks.

[12] See the Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS), Annex I, for further details (available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:02003R1059-20180118&qid=1519136585935).

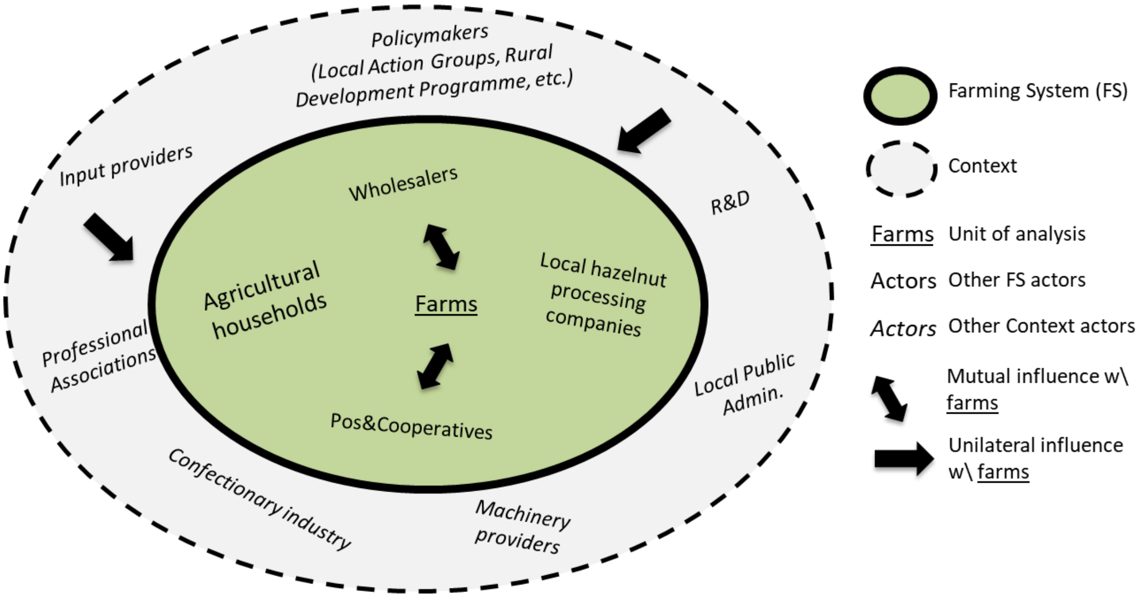


Figure 12.2. Farming system and context actors in the Italian case study area, the province of Viterbo[13].

The farming system is mainly composed of agricultural households provided that the farms in the areas are mainly managed on a part-time basis (Figure 12.2). This is also because labor requirements are high only in the harvesting period and during pruning. Indeed, the allocation of labor between farm and non-farm activities, as well as the contribution of off-farm income sources, are crucial for the functioning of the system, supporting its endurance. The system also includes local traders and processing companies mostly organized into Producers Organizations and a limited number of private companies acting as wholesalers and processing companies. Stakeholders, during the FoPIA-SURE-Farm workshop, also highlighted the role of both institutions managing public support (at local level) and machinery suppliers. These have pivotal importance on the farming activity even if they are only marginally affected by possible evolutions of the local farming sector because operating to larger areas/markets than the one under investigation. Because of this, it was decided not to include them into the farming system, since either of the two-abovementioned actors is directly influenced by the system.

12.3 CHALLENGES

12.3.1 Overview of identified challenges

Table 12.1 synthesizes the challenges identified across methods. A synthesis at farm and farming system level is provided in the next sections.

Interestingly, there is a general ageing problem of farm managers and lack of successors in the farm sector as a whole. However, regarding the specific hazelnut sector, there is not a relevant generational renewal issue, as many young farmers are attracted by the high profitability of the

[13] Please note that R&D stays for Research and Development, and mainly indicate research centres and institutions, both public and private.

sector. Indeed, during the FoPIA workshop, stakeholders scored positively the "retention of young people in the area".

Table 12.1 – Summary of challenges across methods, Italy[14]. Table continues on the next page.

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Hazelnut farms	*1-2 (most relevant)*	*1-2 (most relevant)*	3-4 (least relevant)	3-4 (least relevant)
	Shocks	Learning interviews	New pests, Drought			Delays in RDP payments
		Demographic interviews	New pests			Sluggish regional bureaucracy
	Long-term stresses	Learning interviews		Downstream market power, Intensification, Price volatility	Radicated traditional technique hamper innovation	Lack of R&D from institutions, Lack of trained professional advisors
		Demographic interviews	Climate change in general terms	Downstream market power, Intensification, Price volatility, Turkish market	Farm succession	Lack of proper technical assistance
		Biographical Narratives	Water access and water availability	Buyers concentration, High land values	Farmers ageing and succession issues	
Households	Shocks	Demographic interviews				
	Long-term stresses	Demographic interviews			Farm succession	
Farming system	Shocks	ResAT	Intensive hazelnut production may lead to overwhelming environmental contamination of the area	Rural Development Policies support farmers to cope only with production-related risk		
	Long-term stresses	Demographic interviews, Learning capacities, FoPIA-SURE-Farm		The confectionary industry is pushing towards more domestic production increasing farm-gate competition	Increasing public distrust	
		ResAT		Common Market Organization policies can support the adaptation of the quality of the product to the changing needs of buyers	Some measures of the Rural Development Policies support the take-over of young farmers	The RDP program is very complex and managed with delay in payments

[14] RDP stays for Rural Development Programme (i.e., Pillar 2 payments), while PDO stays for Product of Designated Origin (see the EU website for more details: https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en)

			Environmental	Economic	Social	Institutional
Farming system (past challenges)	Shocks	FoPIA-SURE-Farm	Irregular raining Drought and water scarcity Hail Bugs	Unbalanced bargaining power throughout the chain Price volatility linked to Turkey-related events		Payment delays
	Long-term stresses	FoPIA-SURE-Farm	Increasing temperatures	The increasing presence of hazelnut trees in unusual areas	Farms are becoming larger and small family farms are decreasing in numbers	
		Demo and Learning interviews				Lack of territorial cohesion for making the lobbying activity eventually fruitful (e.g., unsuccessful PDO)

12.3.2 Present challenges for farmers and farm households

Referring to the farm survey conducted, hazelnut growers gave the highest scores to environmental (i.e. 4.73 on average) and economic (i.e. 4.64 on average) challenges, with no statistically significant difference between both; likewise, both institutional (i.e. 3.84 on average) and social (i.e. 3.42 on average) challenges did not show any statistically significant difference between each other.

Considering demographics, learning, and biographical narrative interviews carried out in the case study region, interviewees expressed serious concerns about the increasing intensification of hazelnut production on both the domestic and foreign soils. Indeed, this positive trend would lead to a monoculture dominating both the economy and the landscape, and generating potential environmental problems. Moreover, the concentration of bargaining power in the hands of a few in the downstream chains put more pressure on farmers. Farmers are already trying to diversify their production (e.g. organic production and on-farm production of byproducts as ingredients for the downstream sector, non-farming services such as agritourism). Concerning the environmental challenges, water scarcity and new pests are the most-concerning ones, leading to irrigation systems and researching innovative instruments for pest control. Interestingly, the incoming generation of hazelnut growers is putting more emphasis on the environmental problem, especially regarding the impact of their agricultural activity on the surrounding natural system. Indeed, many have already (or plan to) put in place more sustainable practices for reducing the pressure on the environment (e.g. sustainable agricultural techniques). Their concerns are not only related to the loss in productivity due to climate (i.e. drought, heavy rains, hail), but also the consequences on the quality of the product. The industrial buyers' sector imposes severe requirements on the quality of the delivered hazelnut, with serious implication for the price paid to farmers for their harvest deliveries. Indeed, as reflected within the risk management focus group, both insurance companies and agricultural producers and operators agreed that specific instruments should be developed for coping with quality-related risks.

Regarding social and institutional challenges, they often come together: recently, the local society started to contrast the hazelnut-growing trend. In particular, one municipality located near the Bolsena's lake has indeed banned the new plantation of hazelnut in its territory to prevent possible degradation of the environmental conditions of the lake[15]. They claim that the impact on the environment would be too much, including the worsening of the agricultural landscape. Some other municipalities have introduced constraints to the use of chemicals[16]. All in all, producers fear the introduction of new strict regulation on the use of chemicals and the restriction of some agricultural activities. This is because this is seen as potentially reducing the productivity and profitability of the crop. On the institutional side only, farmers expressed a significant discontent with the delay regarding the payments of Pillar 2 of the Common Agricultural Policy (CAP). Indeed, such payments are managed at a regional level and are experiencing large delays due to regional administrative and bureaucratic inefficiencies. This worsens in some cases the financial exposure of hazelnut producers, especially in case of organic conversion.

12.3.3 Present and past challenges for the farming system

Challenges at the farming system level were identified throughout the SURE-Farm project's activities. Participants highlighted the central importance of economic and environmental challenges. Regarding the first, it has been underlined the very crucial role of Turkey, which represents the largest hazelnut producer worldwide, that is also facing policy instability making the hazelnut market unstable and uncertain. Furthermore, the market is dominated by large manufacturing companies among which Ferrero. Hence, farmers and POs feel very much the strong market powers of these

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[15] Municipality of Montefiascone (Viterbo), 2019: "Misure a tutela dell'ambiente - disciplina uso fitofarmaci e disposizioni su impianti intensivi di noccioleti – Bacino imbrifero Lago di Bolsena." Ordinanza del Sindaco n. 13 del 22 maggio 2019 (*Measures for environmental protection – ruling the use of agrochemicals and other dispositions regarding intensive hazelnut areas – Bolsena Lake's basin. Municipal Ordinance N. 13 of May 22nd, 2019*).

[16] Municipality of Gallese (Viterbo), 2014: "Disposizioni sull'uso e sulla detenzione dei prodotti fitosanitari nell'ambito del territorio comunale per la tutela dell'ambiente, della salute pubblica e delle acque superficiali e sotterranee destinate al consumo umano", Ordinanza n. 20 del 07 aprile 2014 (*Ruling the use and detention of agrochemicals on the municipal territory for protecting the environment, publich health, and water destined to human consumption. Municipal Ordinance N. 20 of April 7th, 2014*). Municipality of Gallese (Viterbo) 2017: "Disposizioni sull'uso sostenibile dei prodotti fitosanitari nel territorio comunale in attuazione del Decreto Legislativo n° 150 del 14 agosto 2012, per la tutela dell'ambiente, della salute pubblica e della biodiversità e in applicazione della difesa integrata", Ordinanza del Sindaco n°30 del 15 Luglio 2017 (*Ruling the use of agrochemicals on the municipal territory implementing the Ligislative Decree N. 150 of August 14th, 2012 for protecting the environment, publich health, and biodiversity and implementing integrated pest management. Municipal Ordinance N. 30 of July 15th, 2017*). Municipality of Fabrica di Roma (Viterbo), 2019: "Disposizioni sull'uso e sulla detenzione dei prodotti fitosanitari e di concimi di natura chimica nell'ambito del territorio comunale per la tutela dell'ambiente, della salute pubblica e delle acque superficiali e sotterranee destinate al consumo umano", Ordinanza Sindacale n° 73 del 24 giugno 2019 (*Ruling the use and detention of agrochemicals on the municipal territory for protecting the environment, publich health, and water destined to human consumption. Municipal Ordinance N. 73 of June 24th, 2019*). Municipality of Vasanello (Viterbo), 2019: "Regolamento per l'uso sostenibile dei prodotti fitosanitari", Delibera del Consiglio Comunale n°15 del 27 giugno 2019 (*Regulation for the sustainable use of agrochemicals, Municipal Ordinance N. 15 of June 27th, 2019*).

large companies. These two economic factors can have a relevant effects on the whole farming system, including farmers, local processors, POs and input providers. An additional challenge comes from the delays in CAP payments: this has direct implication on farmers and, indirectly, on POs (because managing the CMO funds).

Regarding the environmental challenges, the tendency to impose environmental-based restrictions of hazelnut production can hinder the activities of the agents operating downstream, such as traders and POs. These fear that this tendency will reduce production, increase production costs and, because the limits to the use of input, could also reduce the quality of the product. All these have negative imlications that go behind the farm gate only.

12.4 OPPORTUNITIES

12.4.1 Present opportunities for the farming system

Overall, through the discussion in both FoPIA-SURE-Farm, as well as the interviews carried out for both the demographic and learning activities, some opportunities were revealed. Those are mainly related to increase of on-farm value-added of the harvested hazelnuts via more intensive on-farm processing for obtaining both byproducts and final goods, and product diversification (e.g., organic, agritourism) for reaching different marketing channels and different markets. Regarding the environmental side, the incoming young generation of farmers seems to pay much more attention to this aspect, and both organic and integrated production will be possibly developed further the present level.

12.4.2 Past opportunities for the farming system

Stakeholders taking part to the FoPIA-SURE-Farm workshop were to sketch the historic dynamic of the following macro-areas: ‘production of high quality food’ (indicator: hazelnut production), ‘ensure economic profitability’ (indicator: gross margin per hectare), ‘protecting the biodiversity’ (indicator: number of organic farms), and ‘ensure the attractiveness of rural areas’ (indicator: number of young people on the territory). During the exercise, opportunities the FS took advantage of in the past were revealed: the mechanisation in the 1980s and beginning of 2000s, together with the increasing presence of cooperatives (and POs later on). The mechanization has been important for increasing hazelnut’s areas and production during the last 25 years, as well as reducing labour requirements. POs have been important for standardising the quality, channelling CMO policy support, improving the marketing of the product by connecting with the confectionary industry (e.g., concentrating supply, logistics, and shelling). With regards to the gross margin, the dramatic production crisis in Turkey in the recent past caused a huge increase. Finally, the stabilisation of the gross margin in ongoing, mainly due to the stable presence of multinational companies within the sector. Regarding the number of organic farms, stakeholders wanted to highlight how the CAP mechanism fuels “artificially” the numbers of organic hazelnut growers: measures intended for agri-environmental schemes provide a rich premium to farmers producing within the organic code of practice, and to be awarded such premia, the farmer should produce organically for a minimum of 5 years. Due to the perennial nature of hazelnut trees, many farmers claimed to produce as organic in the very initial phases of the biological cycle: since the planting, a hazelnut tree starts producing after 7 years, on average, and during this period it requires a very low amount of inputs. Once the tree reaches the production phase, 5 years (with no production) passed, and the farmer complied with EU rules and received a significant subsidy as organic producer that covered entirely the costs. After this period, farmers can opt-out from the scheme producing conventional hazelnut: this has higher yields and is less risky, especially those caused by insects. Participants interestingly depicted also a second indicator as "biodiversity" as a downward sloping line caused by the very high specialization occurred in the area. Finally, regarding the attractiveness of the area for the younger generation, it seems stable in the focus area, due to high rentability of the hazelnut sector, which generate an offer of local jobs related to the hazelnut sector, while the high mechanisation of the agricultural activities makes them less dangerous and hard.

12.5 FUNCTIONS

12.5.1 Farmers and farm households

Farm survey unveils the preference of hazelnut growers towards delivering high quality food products and ensuring a sufficient farm income, the two most important functions (statistically different), followed by provide employment and good working conditions for employees (statistically different from the two-abovementioned functions), and maintain natural resources (e.g. water, air, soil) in good condition, with the latter not statistically different from the previous one (see Figure 12.3).

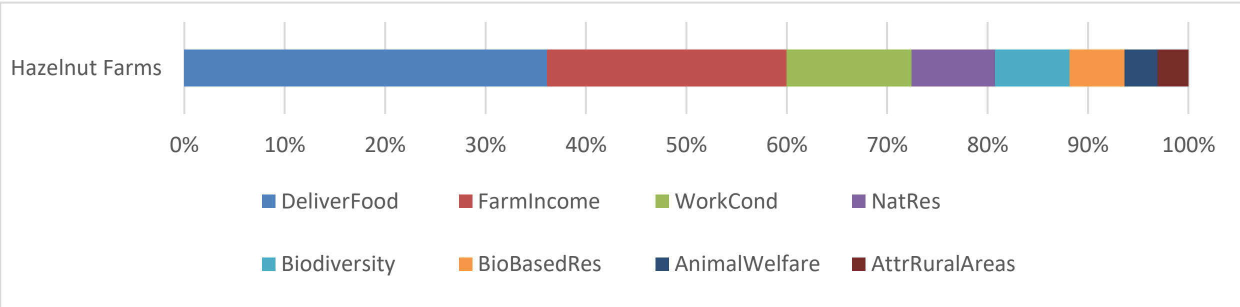


Figure 12.3. Essential functions (averages) according to the farm survey.

Note: FarmIncome – ensure a sufficient farm income; FoodSupply – deliver high-quality food products; NatResources – maintain natural resources (e.g. water, air, soil) in good condition; AnimalWelfare – ensure animal welfare; WorkConditions – provide employment and good working conditions for employees; BiodiversityProtect – protect biodiversity; AttractiveCountryside – ensure the attractiveness of rural areas in terms of agro-tourism and residence; BioEnergySupply – deliver bio-based resources (e.g. hemp, wood) to produce biomass and biofuels

Both the demographic and learning capacity interviews shed light on the depicted functions: new incoming generations of farmers put much more emphasis on the health conditions of their workers, as well as regarding the impact of their agricultural activities on the surrounding environment, when they have to take decisions; and farm income is always at the centre of their decision-making, for example driving diversification choices.

12.5.2 Farming system

The FoPIA-SURE-Farm workshop revealed further insights regarding essential functions for the farming system. While economic viability is still the most important function for farmers, other stakeholders scored natural resources as the most important one.

Figure 12.4 demonstrates how most important indicators (see the bubble' sizes) of private goods score the highest, with food production performing best (3.7; first three indicators). Similar to the demographic interviews, participants of the FoPIA-SURE-Farm workshop scored current performance of public goods functions quite low (all below 3), with diversification of the land use the lowest one with less than 2. Interestingly, one should note how relative important functions scored positively, with an exception for policy support and margins (i.e. value-added) from local processing of the raw hazelnuts.

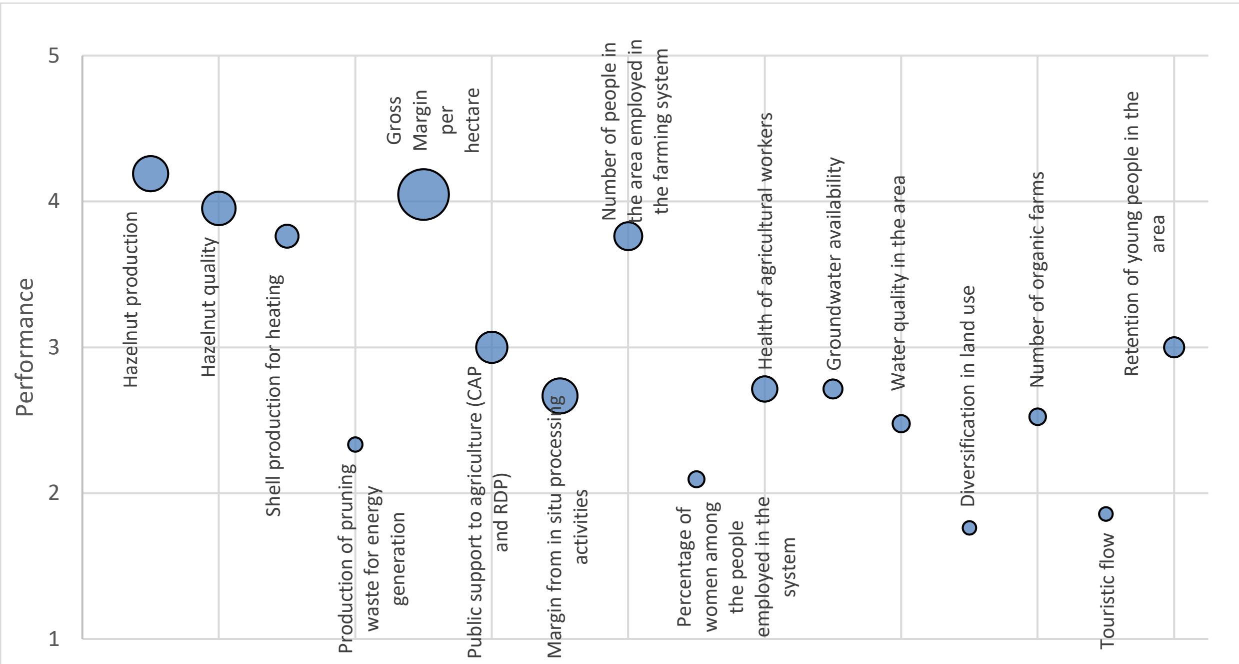


Figure 12.5. Bubble graph presenting averaged scores on the performance of indicators (from 1 to 5), while also indicating their importance (size of the bubbles), relative to each other.

The ecosystem services (ES) assessment suggests that the current performance of food production is not high compared to other EU regions (Figure 12.5). However, this is probably related to the fact that production is accounted for in physical units (tons) that do not fully represent the high unitary value of hazelnut production: hazelnuts are sold at around 3 Euro/kilogram unshelled with an average yield of 2 tons/hectare making the value of production around 5 times higher than that of winter cereals, for example. The other private good also scores low is grazing livestock density. However, this indicator has a large variation across the case study region and refers to a limited share of livestock in agricultural output.

Regarding public goods, most of the services perform poorly, except for equilibrium in phosphorous concentration and capacity to avoid soil erosion (Figure 12.6). The performance of other services is low particularly for habitat quality based on common birds, pollination potential, recreation and oxides of nitrogen (NOx) retention capacity. However, it should be noted that the considered region is very diversified and diverse in nature also within the 10-km-by-10-km squares considered as units of the analysis, suggesting considering these results with some caution.

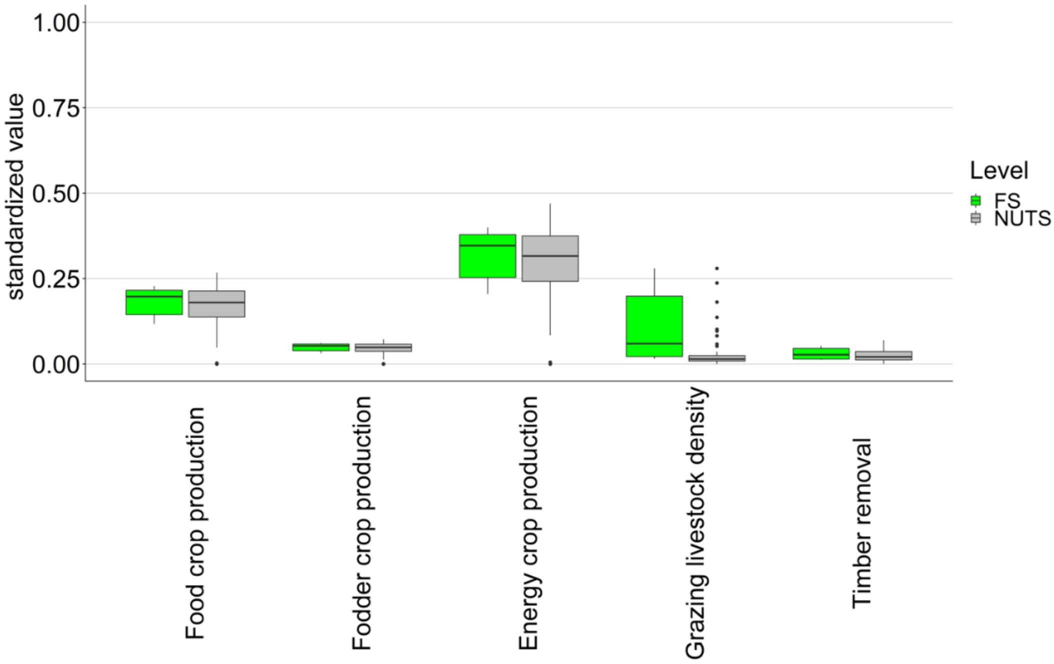


Figure 12.6. Current performance of ecosystem services related to private goods according to the ES assessment.

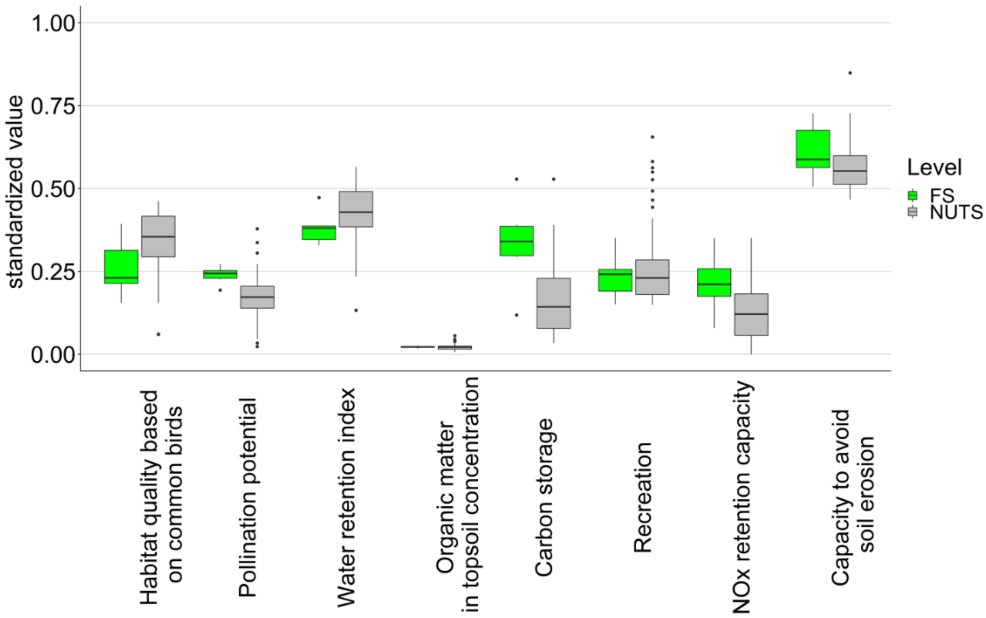


Figure 12.7. Current performance of ecosystem services related to public goods according to the ES assessment.

12.6 RESILIENCE CAPACITIES

12.6.1 Farmers and farm households

Relying upon the answers given by hazelnut growers in the farm survey, there are no large differences among the three dimensions considering the large dispersion of the provided scores (Figure 12.7). The transformability scored highest on average (i.e., 4.40) followed by transformability (i.e., 4.30); robustness scored the lowest (i.e., 3.75). While there is relatively large heterogeneity in the scores provided by respondents regarding robustness and adaptability, this is not the case for transformability. The latter suggests that respondents concord more on this dimension.

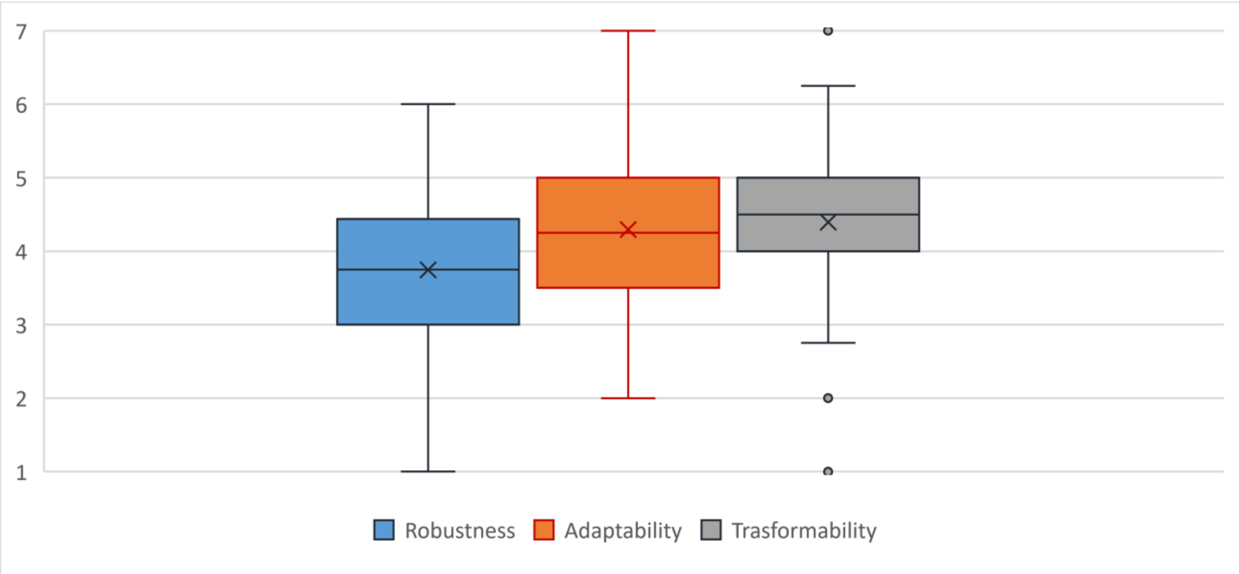


Figure 12.8. Scores for the three 3 resilience capacities based on the farm survey[17].

During interviews, farmers stated there are any risk management strategies concerning the uncertainty of the production volumes and earnings, simply saying that good campaigns serve for cushioning bad ones. This is a clear example of system robustness. Furthermore, the experienced climate change conditions pushed farmers to experiment and adopt new techniques for diminishing the impact of climate shocks, making them more adaptable to changing conditions.

More examples concerning the high adaptability of the farmers were given, especially during learning interviews: on-farm adaptation strategies (e.g., agritourism activities) is on the rise, alike increasing cooperation, as strategies for countervailing the high market power the downstream industry is exerting on the system; the increasing conversion into organic productions testify how producers' concern over the environment and the effect of agrochemicals on the human health are being addressed. All these measures are shaping the current FS, witnessing the adaptability of the system to the changing socio-economic environment. This also embraces their capacity of experimenting and include new techniques for better facing environmental challenges, as described earlier.

[17] Score of 1 is associated with "low resilience capacity" and 7 with "high resilience capacity".

Finally, concerning transformability, interviewees were not prone to a radical transformation. However, this happened in the past, when the area relied upon grazing livestock and other crops and perennials (e.g., arable crops, vineyards, and olive trees). This may raise hopes that, when radical changes will be really needed for the FS to not collapse, farmers would be capable to take on such transformations. Some already had (e.g., switched to agritourism and educational-related activities rather than on agricultural production solely).

Biographical narratives have emphasized similar results. In particular, with reference to robustness capacity, respondents have underlined the importance of formal and informal linkages among farmers and between farmers and non-farmers actors such as local banks, machinery and other inputs suppliers.

As a response to the high values of agricultural land in the farming system area adaptation capacities, shown through the narrative survey, are represented by farms that have expanded their hazelnut business buying land in neighbouring regions where land values were much lower. Diversification through agritourism or other non-farming activities is a further adaptation capacity emerged from the biographical narratives. The long-term nature of the prevailing cultivation together with the lack of profitable alternatives have limited radical transformation initiatives. Nevertheless, results from the farm survey point to the opposite, scoring transformability the highest. This relates to past experiences respondents incurred, as many witnessed the transformation to the hazelnut cultivation.

12.6.2 Farming system

Looking at the draws for indicators concerning 'production of high quality food', 'ensure economic profitability', 'protecting the biodiversity', and 'ensure the attractiveness of rural areas' the FS shows certain level of robustness for the first three indicators (actually, FoPIA-SURE-Farm-workshop participants reported a growth of the first two and a steady-state for the fourth one), albeit biodiversity is steadily declining. According to the stakeholder's sketches of indicators, one can grasp that some adaptation occurred in time: cooperatives to counterbalance strong downstream power, recurring to CAP and converting to organic to differentiate and cushioning costs, farm enlargement, and mechanisation are some adaptive strategies the FS undertook to respond to changing conditions. Institutional, environmental and economic challenges (e.g., Turkish agricultural policies for hazelnut, market and environmental crisis curbing production, massive investments by the confectionary industry) occurred and have been overcome by the FS.

Figure 12.8 illustrates how stakeholders consider that strategies applied in the past contributed to each of the three resilience capacities. Results are mixed: regarding hazelnut production and quality, strategies contributed more to robustness, with adaptability and transformability roughly equally scored; with regards to profitability, mechanisation supported more adaptability than robustness, and hindered transformability, whereas POs pushed for transformability more, followed by adaptability, while robustness scores far below; the number of organic farms contributed positively to transformation, and negatively for both adaptability and robustness; finally, for retention of young people in the area, mechanisation again supports more robustness, while value chain activities equally worked for robustness and transformability, while slightly better for adaptability.

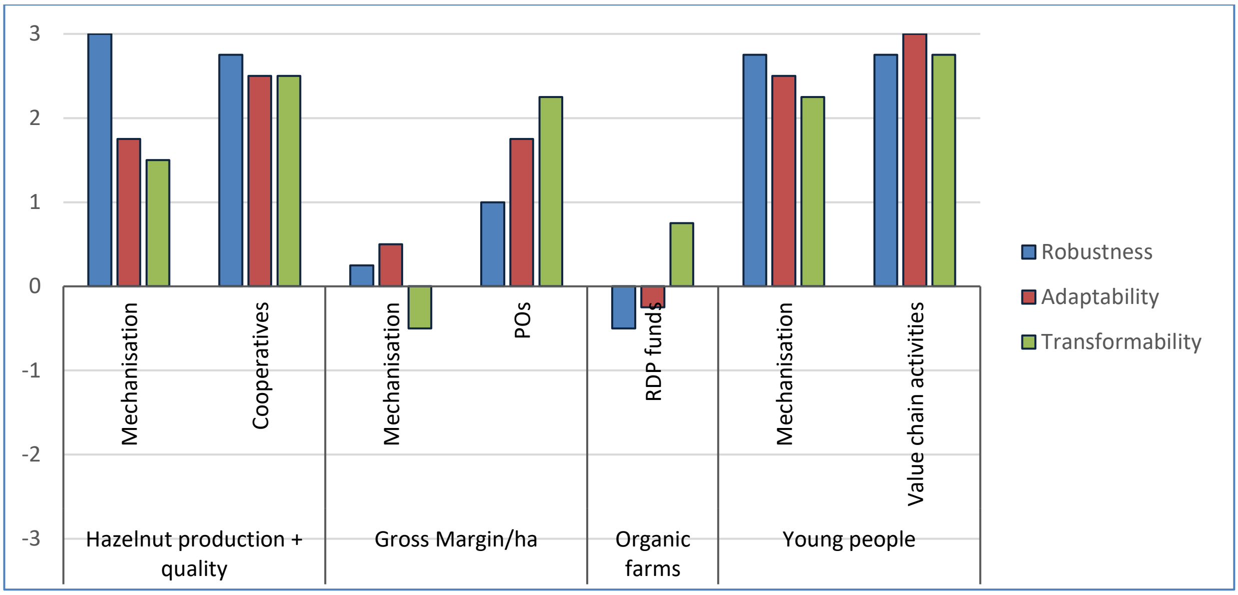


Figure 12.9. Strategies applied to cope with challenges affecting the indicators hazelnut production, gross margin per hectare, number of organic farms, and the number of young people on the territory[18].

According to the stakeholders, resilience attributes are present to a moderate extent, and contribute most to robustness and adaptability, and then to transformability (see Figure 12.9). For robustness and adaptability, a strong synergy can be identified for the "Coupled with local and natural capital (production)", and between all three capacities for "Socially self-organized" and "Infrastructure for innovation". The latter two seems quite positive correlated with transformability too.

[18] Participants had to score between -3 ("heavily constraining resilience of the FS") and +3 ("heavily enhancing resilience of the FS").

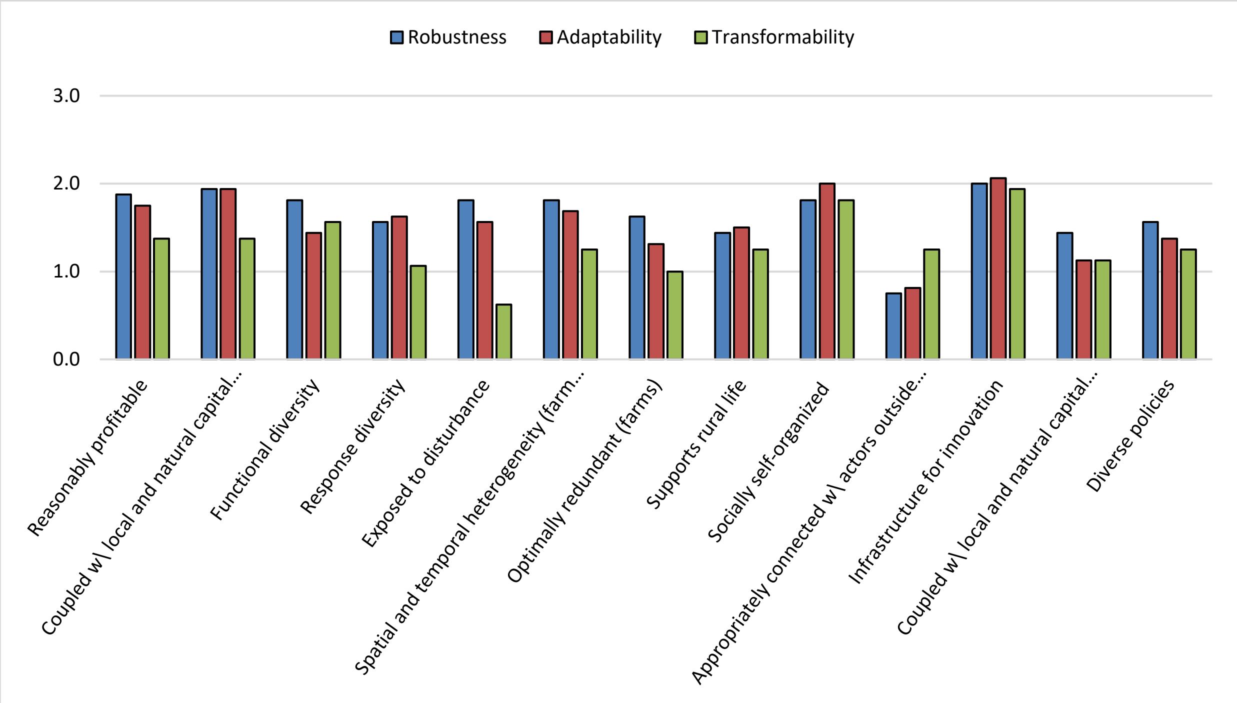


Figure 12.10. The contribution of 13 selected resilience attributes to 3 resilience capacities, according to the stakeholders in FoPIA-SURE-Farm workshop[19].

The ResAT analysis shows that, given the characteristics and the specialization (hazelnut crops) of the farming systems prevailing in the area of this case study, the main policies involved are the Rural Development (RD) policy and the Common Market Organization (CMO) for fruit and legumes. Indeed, the role of Direct Payments is limited because the amount per hectare is not large in comparison with the sales' revenue.

The general picture coming out from our analysis points out that such policies address mainly the farming systems adaptation to external factors with some concern for the survival of the activity in the short-run (Figure 12.10). The Risk Management measures provided by the RDP could in principle support farmers to cope with production risk. However, take-over of these measures is limited in the case of hazelnut so far. Adaptability is fairly supported by the CMO measures widely used by the POs' operational programs. These programs usually focus on mid-term adjustments with particular concern to promoting farming systems flexibility and variety of adaptation patterns.

[19] Note that the scale is from 0 to 3, where 0 is "no contribution to resilience" and 3 is "highly positive contribution to resilience".

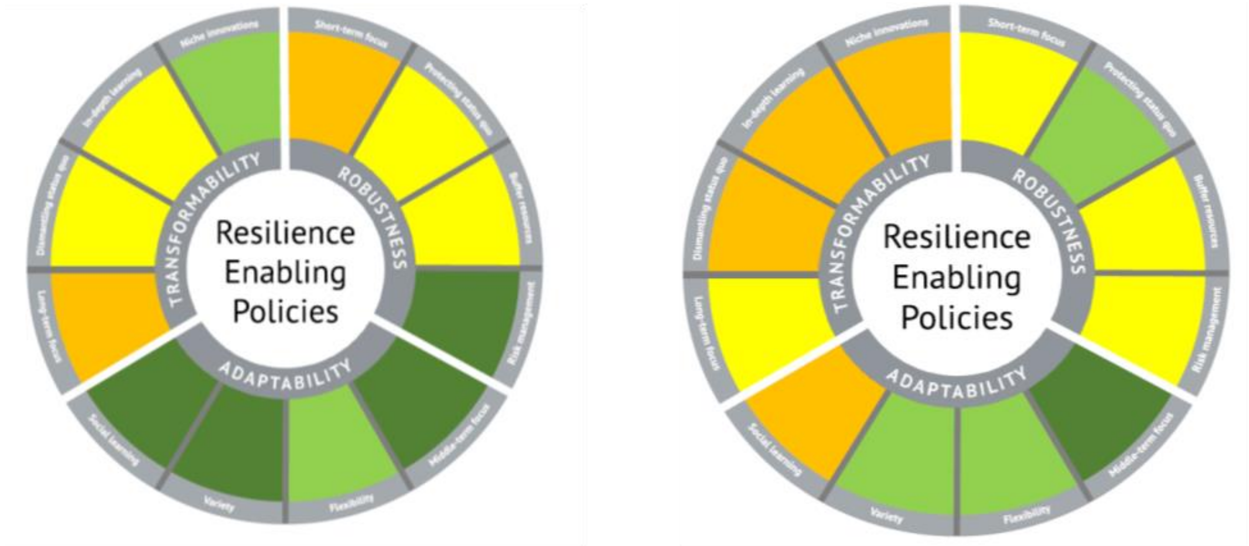


Figure 12.11. The ResAT wheel applied for the arable farming system in the Viterbo case study (Goals depicted on the left-hand side graph, wheres Instruments on the right-hand one). The attributes are the key characteristics for resilience-enhancing policies. The given colours indicate to what extent the key characteristic is enhancing or constraining the resilience capacity.

Short-run and status quo protection goals address mainly protection from occasional catastrophic/natural events and market crises. Only RD partly address farming systems transformability, in particular through the program for young farmers and the European Innovation Partnership for agriculture (EIP-Agri). The CMO policies managed by the Producers Organization allows supply chain coordination making the farming system able to adjust according to the request of downstream industries. However, the POs are fragmented and, in general, relatively small in comparison with the downstream industry dominated by few very large operators.

12.6.3 Concluding remarks on resilience capacities

Robustness is mainly enhanced by the high profitability, as well as by the high self-organization (which increases all three capacities, and particularly adaptability). The transformability of the system is currently low, as most of the attributes that could enhance this capacity ("Functional diversity", "Appropriately connected with actors outside the farming system") have a low presence. Adaptability is also present.

POs have had a low impact on the robustness of the system, and a medium impact on its adaptability and transformability. The strategies based on mechanization appears to bear a diverse impact on resilience capacities: positive and strong for all three when referring to "retain young people in the area"; and regarding agricultural production has increased the system's robustness. As for the economic side, it has had a weak impact on the capacities of the system, due to the costs that mechanization implies that counteract its positive effect on returns. RDP funds had an unclear role in influencing the resilience of the system.

All in all, the farming system is mainly robust, although, individually, both adaptability's and transformability levels are present.

12.7 RESILIENCE ATTRIBUTES

12.7.1 Farmers and farm households

Networks are significantly relevant for hazelnut growers. This stems from the survey (together with all the other interviews performed), where, on average, the integration into the network was highly scored. Due to the strong sense of community, there exists a high level of peer-to-peer learning, pushed further by seminars and meetings, especially when organized by POs. Indeed, cooperation is widespread, as well as vertical collaboration, and many innovations came out from experimentation under the guidance of other actors (e.g., machinery suppliers, research centers). Such findings are cemented by the demographic interviews, where POs are good for updates and information and the management of CAP funds, as well as cooperating with other agents of the supply chain. Such strong network seems to be well represented by the higher scores for *modularity*, while *openness* was poorly represented, reflecting the high specialization of the FS and its very weak and non-significant connections with actors outside the system, together with a deep-rooted agricultural tradition that sometimes may discourage innovations.

Diversity also appears weakly represented by the FS, as only "spatial and temporal heterogeneity of farm types" scored high, with all the remaining diversity-related attributes scoring very low. Households, on the other hand, seem to perform well in diversity, as testified during the demographic interviews. Indeed, many agricultural households rely upon some other activities, as agritourism and on-farm transformation. In addition, as specified in the introductory section, the lion share of the FS is well represented by small farms, often part-time farms, in which the farmer engages in off-agricultural jobs.

On the contrary, *system reserves* scored the highest, although mainly linked to economic reserves. Often used as a risk management strategy, due to the high level of profitability of the sector in recent years, farms and agricultural households save economic capital to cope with unexpected shocks.

12.7.2 Farming system

According to the output of the FoPIA-SURE-Farm workshop, resilience attributes are moderately present in the Viterbo FS (Figure 12.11). Diversity, scored low as expected, as the system is highly specialised into hazelnut production. Indeed, "Response diversity", "Functional Diversity", and "Diverse policies" all scored low. Risk management measures are not very developed at both public and private levels, while there are no specific political actions tailored on the system's needs. "Spatial and temporal heterogeneity of farm types" is the only highly ranked by stakeholders.

Modularity is amongst the better scored, mainly due to the high performance of "Optimally redundancy of farms", "Supports rural life", and "Socially self-organized". Regarding the former, it well reflects the positive generational renewal that is underway in the FS: the high profitability of the sector encourages youngsters to take over the farm and continuing farming in the FS; the second attribute refers to the capacity of the FS to support the living in rural areas, a statement stakeholders ranked quite high, as the hazelnut sector is retaining people on the territory; finally, the high performance of the self-social organisation explains the strong linkages and relationships existing amongst the actors of the FS, especially farmers, which often result in establishment of cooperatives and POs. Concerning “Legislation coupled with local and natural capital”, the score indicates quite poor performance, and pointing to the unsatisfactory level of agreement between stakeholders and public administrations, with local legislation hardly suited, and tailored, on the FS needs and characters. On the one hand, this relates to the lack of a specific legal framework for protecting the natural areas, especially regulating and banning some agrochemicals and agricultural techniques. On the other hand, there is an incipit of refusal towards the hazelnut, with some municipalities banning the plantation of hazelnut trees on their territories, fearing the monopolisation of the landscape and the contamination of the environment. “Spatial and temporal heterogeneity of farm types” also scored high, due to the variety of farm sizes and degree of specialisation.

As in other specialised case study (e.g., starch potato in the Netherlands), the combination of positive *modularity* and low *diversity* may indicate the room for improvement for risk management strategies, together with some dependence from downstream chains of the system, and, regarding this specific case study, the pivotal role of agricultural associations (i.e., cooperatives and POs).

System reserves, performed the best in the view of stakeholders, especially concerning economic reserves. Indeed, as described earlier, the economic performance of this particular agricultural sector featured a largely positive trend in the last years, allowing agricultural households to save economic capitals. This, together with high scores for “Support rural life”. On the other hand, production coupled with local and natural capital scored low.

Tightness of feedbacks of the system was well represented by the attribute “Socially self-organised”, but the connection with actors outside the farming system was low. Low was also “Legislation coupled with local and natural capital” and “Diverse policies”, pointing to low modularity and diversity of policies, similar to the Netherlands case study.

Finally, *Openness* of the system was weakly represented, with a moderate to low presence of “Infrastructure for innovation”, and low “Exposed to disturbance”, as poor to none relationship exists beyond the very FS.

Looking at constraining attributes, policy measures are marginally supportive and efficient. Furthermore, rooted culture and tradition, together with poor infrastructure to innovation and very poor connection with the outside of the FS may siege innovation and transformation within the FS.

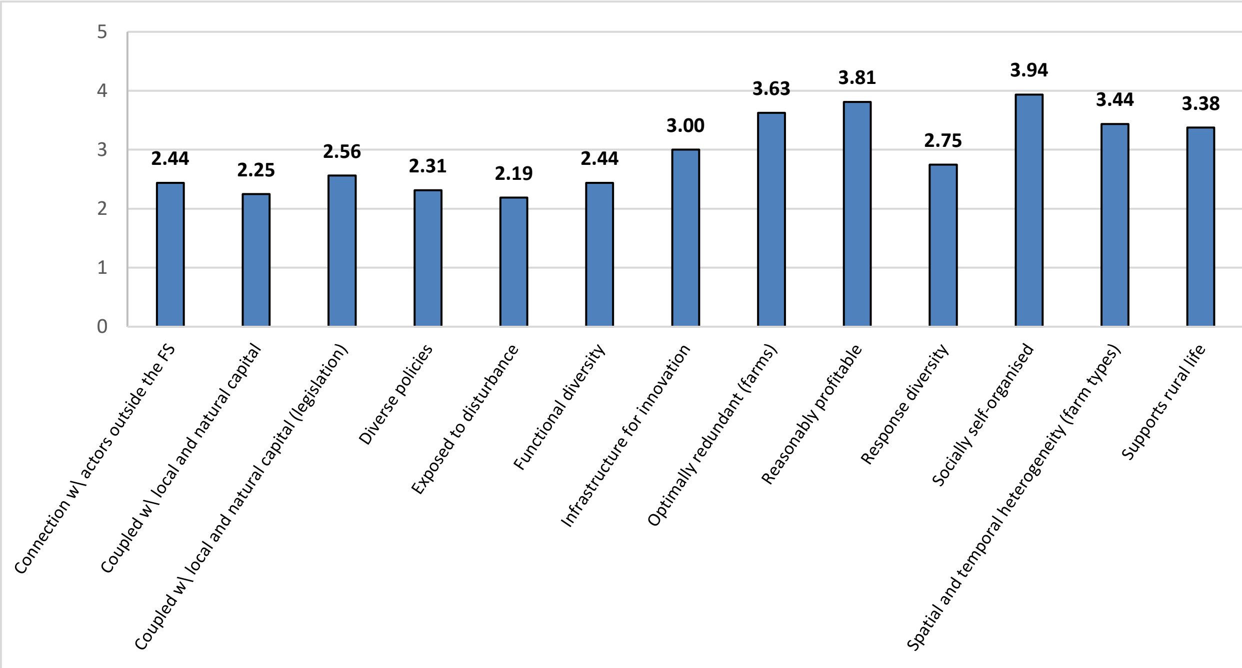


Figure 12.12. Performance of attributes on a scale from 1 (not at all performant) to 5 (very big extent of performance), n=16.

12.7.3 Concluding remarks on attributes

Considering the four different processes, namely agricultural production, risk management, farm demographics, and governance, the system performs moderate to high regarding farm demographics and agricultural production, whereas moderate to low with regards to risk management and governance. However, while risk management strategies overall perform poor, governance performs poorly only in terms of policy, whereon the focus should be put; in contrast, local self-organisation is one of the most high-scored attributes as explained in the previous sections. According to the ResAT analysis, the CMO support to POs seems to be a useful tool for supporting innovation and enhancing adaptability of farm production to the changing product standards requested by the downstream industries. In contrast, POs does not seem to be able to address market instability and the large concentration of the downstream industries. RDP policies could support transformability especially by providing incentives for the takeover of young farmers. However, these policies are perceived as being very complex, and the related administrative process is very slow and uncertain. Finally, there is room for improving the robustness of the system by increasing the currently low takeover of the risk management tools supported by RDP policies.

Table 12.1. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Heterogeneity of farm types (FD, RM)	Low functional diversity (AP, RM) Low diverse policies (G) Low response diversity (RM)	Multifunctional farming (AP, RM)	Mutually dependent on downstream processing industry (RM, G)

Openness	Increasing differentiation and diversification of farms (AP, RM), Medium infrastructure for innovation (AP, G)	Low exposure to disturbance (RM), lack of policy instruments for a different status quo (G), lack of relationships w\ FS' outsiders (RM, G)	Incoming generation more open to change (FD, RM, AP)	Resistance to change (RM), Rooted traditions (RM, AP)
Tightness of feedbacks	High level of self-organization (e.g. cooperatives, POs)(G), High redundancy (FD)	Connection with actors outside the FS inappropriate (G)	Engaged in networks, vertical collaboration, experimentation (G, RM, AP)	
System reserves	High profitability (AP, RM)	Production is hardly coupled with local and natural capital (AP) Low policy instruments on buffer resources and risk management (RM, G) Moderate level of infrastructure for innovation (AP, G)	Alternative off-farm income (RM)	High specialisation (AP, RM), Downstream industry' market power on the upstream chains (G, RM), Social discontent (G, RM)
Modularity	High redundancy (FD), High heterogeneity in farm types (FD, RM)	Lack of specific policy instruments (RM, G)	Reflexivity, experimenting (AP, RM), peer-to-peer learning (G, RM), Positive farmers renewal (FD)	Resistance to change (RM), Rooted traditions (RM, AP)

12.8 ADAPTIVE CYCLE

The farming system seems to be near its conservation phase, after having undertaken a growth in the last years. However, due to the push of the confectionary industry towards more aggressive hazelnut domestic production, the Viterbo FS could rapidly face the collapse phase, as agricultural competitive pressure, blended with remarkable downstream market power, could endanger the system endurance. The high profitability of the sector shaped the FS, with farms that are starting differencing and differentiating but yet highly specialized in hazelnut and, hence, highly dependent on its trends. For instance, there has been an enlargement of many farms, planting hazelnut on new land or by purchasing neighboring surfaces.

Concerning the four processes (Figure 12.12), both *agricultural production* and *risk management* are kept in the re-organization phase. The former, as already described throughout previous sections, is experiencing the entry of young farmers, whom often embrace a different vision when compared to their predecessors, with high environmental sensibility and innovative ideas, especially for diversifying the activity. Conversion towards organic and integrated production, cultivation of other crops and perennials, and the development of other related-activities (i.e., agri-tourism, on-farm processing, different marketing channels) are slowly entering into the FS, shaping its nature. Concerning risk management, along many activities farmers often expressed their discontent because of the lack of dedicated instruments. Indeed, during the risk management workshop, also insurance companies admitted their scarce interest in the sector, albeit due to the economic turnover new tools are coming for covering farmers' needs. Likewise, the scant presence of credit institutions on the rural territory is a weakness that prevents many farmers to access credit for financing, calling for the return of such institutions near the hazelnut growers. The re-organization does not mean that a collapse phase will be featured, but incremental changes are needed for reaching a new phase in the adaptive cycle.

Governance is in its conservation phase, albeit recent social discontent concerning the hazelnut impacts on the environment and landscape are raising serious concerns. Especially, farmers fear the ban of some practices and chemicals, which can hinder the productivity and the quality of the plantation. On the one hand, nothing really happened at the policy level in the last years, with the local PDO still not used by hazelnut growers, and CAP funds not changing very much for farmers in this specific sector. However, on the other hand, environmental groups and some municipalities fought vigorously against the expansion of the hazelnut on the Viterbo territory, reaching the point that in some locations the local government banned the plantation of new hazelnut trees.

Finally, with regards to *farm demographics*, the system found itself at the growing phase: due to the high profitability of the sector, young generations are very keen to continue the farming activity, often owned by their family. Indeed, many future farmers are studying agronomic-related courses at Universities in view of their future active participation into the FS. Indeed, the Viterbo case study represents a unique positive example of generational renewal in agriculture, whereas, on average, European agriculture is experiencing an ageing process with very low and worrying levels of renewal. Often, the future involvement of the youngest members of the family pushes farms to enlarge, to pursue economies of scale and ensure some stability in the market. In this regards, many small family farms have been purchased and absorbed by larger ones.

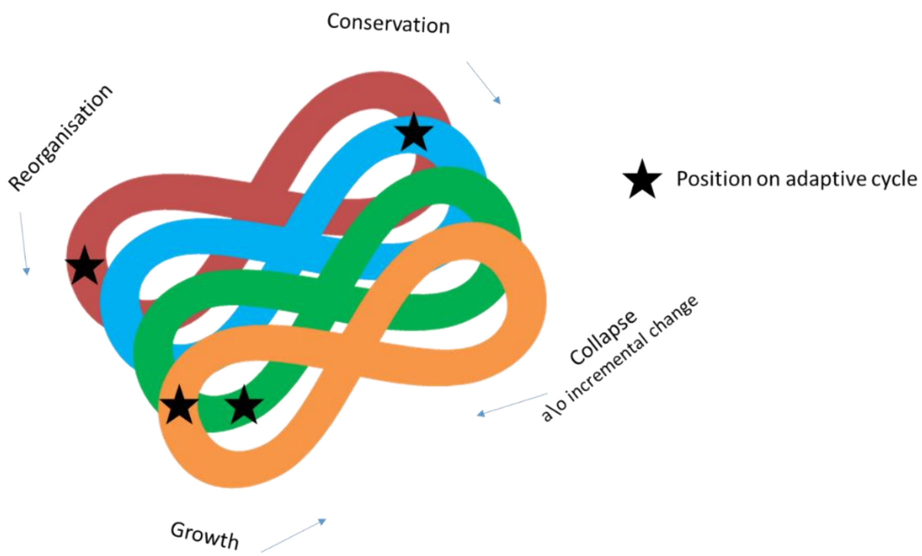


Figure 12.13. Positioning the Italian farming system on the adaptive cycle of processes in agriculture.

12.9 STRATEGIES

Strategies for the future may focus on improving robustness in order to better cope with incoming challenges mentioned earlier, and strategies focusing on improving transformability in order to allow for the reorganization may be more viable in the long-term. Table 12.3 summarizes future strategies mentioned per process.

Table 12.2. Future strategies per process for the Italian case study.

Process	Future strategies
Agricultural production	- Introduce new technologies (e.g. new varieties, new techniques and new products to cope with adverse climate events and incoming pests). - Enhance diversification (agritourism activities, new crops) and differentiation (new production methods, e.g. organic and integrated production) - Improving on-farm processing to add value and entering new marketing channels
Farm demographics	- Maintaining the economic attractiveness for the youngest generations - Enlarging the farm for pursuing economy of scale - Improve the quality and increase the offer of skilled workforce, able to use machinery - Incoming generations are calling for a more sustainable production method to reduce environmental stress and employees' health-risk - More research on diverse production methods and bug control, and on how to maintain a high quality of the harvested fruits
Governance	- Develop tailored policies - Involve social parties calling for more conscious agricultural practices; - Avoid social confrontations; - Fostering upstream cooperation and agglomeration for countervailing strong downstream market power and do more lobbying regarding policy instruments better tailored for the specific sector (e.g. RDP and CMO). - Facilitate adaptation\transformation through developing infrastructure and financial support;
Risk management	- Both insurances and banks should be more present on the territory and offer tailored solutions on farmers' needs and according to risks the hazelnut cultivation poses.

12.10 CONCLUSION

The recent surge in hazelnut price and demand suddenly put the Viterbo FS in the spotlight. The turnover it generates is surprisingly high, representing one of the most profitable agricultural sectors in Italy at the moment. Previously covered with vineyards, olive trees, arable crops and grazing livestock, the agricultural sector of this territory transformed. Nowadays, the region is the second major hazelnut production of Italy and one of the leading ones worldwide.

However, the quasi-monopolistic structure of the demand (i.e., very few industrial processors, with one leading industrial processor and a few secondary ones) shape this specific supply chain. More specifically, leading downstream confectionary industry imposes quality requirements and pushes towards expanding the Italian hazelnut production. In fact, the unstable sociopolitical conditions in Turkey, together with risky yields (e.g., aflatoxins and quality of the harvested hazelnuts), make multinational firms better off buying larger shares of hazelnut on more secure soil, like that of Italy, with known higher quality. This translates into pressures onto the farm-gate level, composed by a myriad of small family farms unable to countervail the market power of industrial processors, and obliged to subdue to their requirements in order to place their supply on the market. In this regard, adaptation strategies have been put in place, with cooperatives and POs resulting in a valid instrument to gather producers and increase their capacity to get organized to face the growing complexity of the market needs and to support technical innovation. However, they are yet able neither to increase their bargaining power nor to gain the value-added derived from the processing of the raw material. Furthermore, an intense informal peer-to-peer network of knowledge exchange, experimentation, and vertical cooperation with other agents of the FS made the system robust, but less apt for changes and, even less, transformation. Indeed, the rate of retention of young people in the territory is seen as high by stakeholders, recognizing the positive effect of the hazelnut sector (this has been further cemented by the positive generational renewal the FS is experiencing).

Households seem to be more resilient when referring to adaptability, as many already initiate diversification strategies on their farms, including some agritourism activities, crop diversification, and entering different and niche markets (e.g., organic conversion, serving directly the consumer market). In any case, most of them have also off-farm income sources. At the system level, however, farms are pointing at enlarging their surface to pursue economies of scale and be able to better cope with future environmental and economic challenges. Transformation seems to be yet unachievable, and probably because the sector is still in very good health, especially when compared with other agricultural productions. In light of this, insurance companies have already expressed the desire to develop some tailored instrument for risk management, especially regarding environmental shocks and to ensure the quality of the harvest.

13 CASE STUDY POLAND

Vitaliy Krupin, Katarzyna Zawalińska, Błażej Jendrzejewski

13.1 ABSTRACT

The aim of the following report is to aggregate and synthesize previously gathered results and conducted analyses in the framework of SURE-Farm project concerning resilience of horticulture farming system in Mazovian case study area in Poland.

Utilized approach is based on SURE-Farm methodology (Meuwissen et al., 2019) and consequently deals with the following issues: definition and elaboration of the farming system, outlining of past and existing challenges and opportunities, evaluation of essential functions delivered by the farming system, resilience capacities and attributes. Furthermore, definition, visualization and substantiation of current stage in the adaptive cycle for the particular farming system are performed in order to understand the past developments, present peculiarities and the future expectations concerning this system and its actors in several processes (risk management, governance, demographics and agricultural production).

The farming system analyzed here (Figure 13.1) consists mainly of the small family farms in Mazovian case study area in Poland (including two NUTS2 regions: Mazowieckie and Lubelskie), especially those specialized in horticulture but also other farms providing manure supply or doing common crop rotation for those farms. Other actors include farm organizations, local financial institutions, insurance companies, retailers and other units which affect the farms and the farms also have impact on them. The farmers and the entire system face challenges – some inherited from the communist past (e.g. low cooperation due to farmers distrust and some other resulting from the global trends, e.g. extreme weather events). The system tries to sustain the essential functions and is doing well in delivering high-quality products and maintaining natural resources however struggles to ensure sufficient farm income, attractiveness of the rural areas and to protect biodiversity. Currently the resilience capacities are low to moderate and there is relatively higher policy support for robustness rather than adaptability and it neglects transformability although individual farms would appreciate the most transformability enhancement. Concerning the resilience attributes, what currently enhances the resilience is production coupled with local and natural capital and what constrains it the most is the lack of long-term profitability and its current high volatility. What is specific in the Polish case study is that the horticulture sector does not rely so much on CAP support in terms of money, it rather seeks more support in terms of good regulations of markets. That is crucial taking into account perishability of the products and high dependence on contracts. However, the policy is perceived by the farmers and the system as over regulated. So the tightness of feedback is generally moderate for this system. The adaptive cycle for the system shows the phase of growth for agricultural production and risk management, the phase of reorganization for governance (policies and structures) and is at the edge of collapse for farm demographics. So the overall position on the adaptive cycle is between growth and conservation.

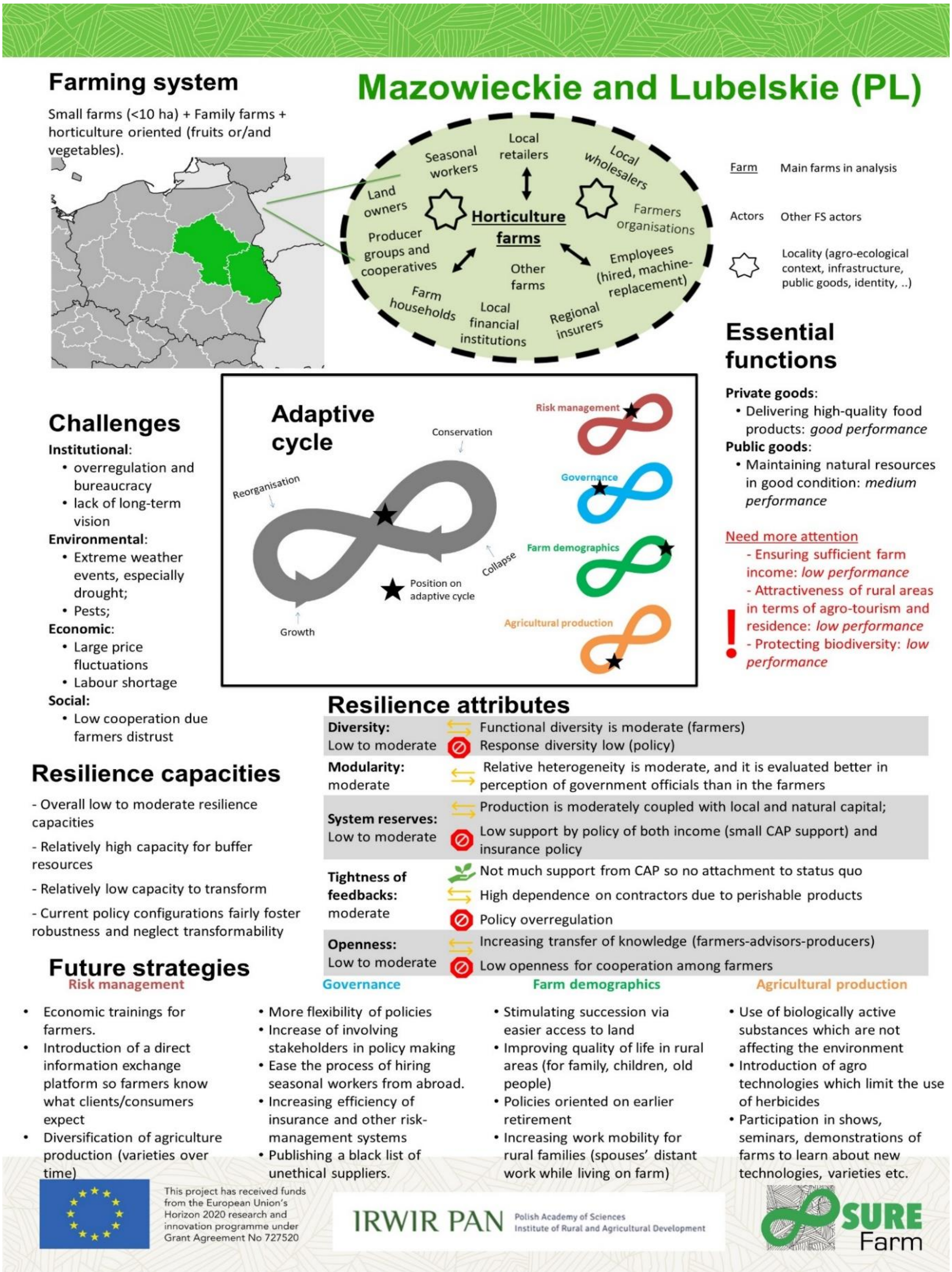


Figure 13.14. Factsheet synthesizing current resilience of the horticulture faming system in Mazovian case study area, Poland

13.2 FARMING SYSTEM

Mazovian case study area includes two voivodeships in Central East Poland being two NUTS2 regions: PL92 (Mazowieckie) and PL81 (Lubelskie)(Figure 13.2).

This region is traditionally dominated by horticulture, determined by its diversified landscape. Depending on particular area the key hard fruits are: apples, pears, plums, cherries, sweet cherries, to less extent peaches and apricots; among the soft fruits: strawberries, raspberries, currants (black and red), and gooseberries. Most popular vegetables chosen for cultivation by farmers are onions, carrots, cabbages, cucumbers, tomatoes, and sugar beets.

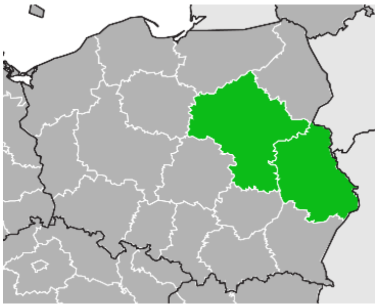


Figure 13.15. Geographic location of Mazovian case study area, Poland

The typical farm types defined for the Mazovian case study area include the following five, based on the SURE-Farm Deliverable 3.1 (Bijttebier et al., 2018):

- TFT1: small farms (<10 ha) + Family farms + Arable farming (Field crop farms),
- TFT2: medium farms (10-30 ha) + Family farms + Arable farming,
- TFT3: medium farms (10-30 ha + Family farms + Milk farms,
- TFT4: small farms (<10 ha) + Family farms + horticulture (fruits or/and vegetables),
- TFT5: small farms (<5 ha) + Family farms + poultry farm (farming based on purchased fodder inputs).

The key farming system relevant for the Polish case study in the SURE-Farm project is the TFT4. Horticultural production is mainly carried out by farms with less than 10 ha, most being family farms.

Figure 13.3 presents the social composition of the Mazovian case study area horticulture farming system. In the inner circle are the actors which influence the farming system and are equally influenced by the farming system while mutually influencing each other, too. These actors include horticulture (fruit and vegetable) farms, farm households, other farms, land owners (including land lenders), employees (hired workers, machine-replacement), seasonal workers, local retailers, local wholesalers, local financial institutions, local insurers, farmers organizations (unions), as well as producer groups and cooperatives.

The actors who influence the farming system, but who are themselves scarcely influenced by the system are presented in the second circle in Figure 13.3. These include processors, banks and financial institutions, suppliers of inputs (e.g. fertilizers, pesticides), regional and national retailers, agricultural media (newspapers and journals, websites – e.g. farmer.pl, agropolska.pl), advisory (extension) services (state and private), local authorities (e.g. issuing permits).

The second circle of the Figure 13.3 is also depicting the actors of indirect influence upon the farming system, yet having strong effect nevertheless. These include EU policy makers (e.g. though CAP), national public administration (e.g. Ministry of Agriculture and Rural Development), export markets, consumers, citizens, environmental NGOs, social NGOs and researchers (e.g. Institute of Rural and Agricultural Economics – National Research Institute, Institute of Soil Science and Plant Cultivation – National Research Institute and other).

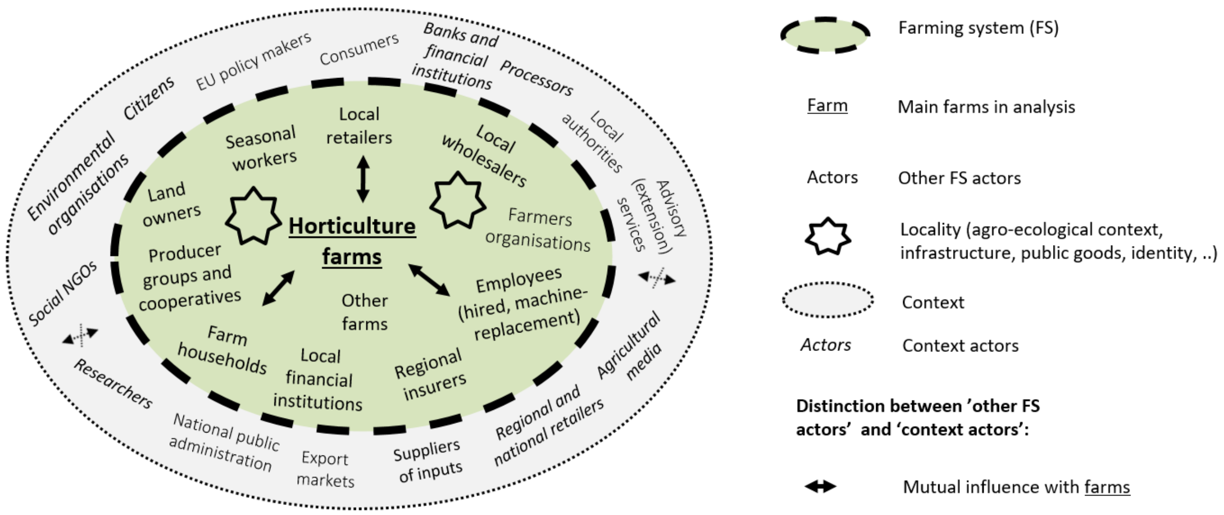


Figure 13.3. Horticulture farming system in the Mazovian case study area.

After regaining independence in 1918, Poland was a typically agricultural country with a huge predominance of small farms, especially in the areas of present-day Central and Southeastern Poland (including the Lubelskie and Mazowieckie voivodeships). Due to agrarian overpopulation, the organization of the production activity of most of these farms, especially in the entire interwar period, was geared towards the survival of the peasant family and production of as wide selection of products as possible (in order to both sustain the family and to sell the excess products). Typically these were farms cultivating up to 5 ha of agricultural land, being weakly connected to the market and increasingly basing its sustenance on their own production. It was the effect of the continuing population growth in the entire interwar period from 1930, as well as the worldwide economic crisis. After the Second World War, demographic pressure gradually weakened. Despite a nearly seven-fold increase in national income in 1946-1989, at the threshold of the system transformation, every fourth Pole still worked in agriculture. According to estimates from 2017, the share of those depending with their incomes on agriculture decreased to around 12%. However, in crisis years, such as during periods of systemic and economic transformation (1989–1994), agriculture played the role of a "warehouse" for labor surplus, mainly on small farms. One of the ways to manage these surpluses was to introduce labor-intensive activities, including horticultural production. Accession to the EU continued to influence the decrease of agricultural employment with simulations growth of agricultural production.

13.3 CHALLENGES

13.3.1 Present challenges for farmers and farm households

Farm survey. For Polish case study region environmental challenges were defined as the most relevant (scoring 5.2), among which the persistent extreme weather events (e.g. floods, droughts, frost) and the pest, weed or disease outbreaks were singled out as most influential. Economic challenges facing the farmers and farm households being perceived as second according to their influence (5.2) are oscillating around pricing issues, as the persistently low market prices, farmer's low bargaining power towards processors and retailers and persistently high input prices (e.g. fertilizer, feed, seed) were given highest challenging scores. Then come the institutional challenges (4.3) defined mainly as reduction in direct payments of the Common Agricultural Policy (CAP) and the least influential are the social challenges (3.8) with the top challenge being the lack of seasonal workers and limited availability of skilled farm workers. Among additional answers given by the farmers in the farmer's survey the structure of key challenges is slightly different, as they include: social challenges (lack of successors), economic challenges (problems with improvement of the structure of Polish farms), institutional challenges (lower payments), environmental challenges (deficit of organic matter in the soil).

The **learning interviews** allowed the researchers to outline key challenges the horticulture farmers are facing. Economic and institutional challenges seemed to be occurring most often in the interviews, then environmental and social. There was no distinction between long-term challenges and shocks. Among the economic challenges the most influential are the price fluctuations, fall of the profitability of production, and gradual, yet constant increase in prices of pesticides, fertilizers, fuels and salaries of seasonal workers (e.g. minimum payment per hour). Institutional challenges include highly bureaucratic system of employing workers from abroad (crucial for Polish farmers lacking domestic workforce and relying primarily on seasonal workers from Ukraine), bureaucratic system for obtaining quality certificates, withdrawal of effective plant protection products, implemented system of auctions for supply of fruits to public facilities (in which mainly the price decides and not the quality of supplied products), embargo on exports to Russian markets, latest land market restrictions. Environmental challenges are the following: droughts and ground frosts, hail, intensification of pest appearance (mainly insects, which requires a much larger number of plant protection treatments), fluctuations in yield. Key social challenge in almost all interviews is the problem with successors or lack of such.

Demographic interviews focused primarily on social and succession issues in farms, yet many other issues have been tackled as well. Most interview results concerning challenges are correlating with the learning interviews described above. Thus the key challenges defined were economic (high volatility, low profitability, unfavorable output/input price ratios, lack of economic incentives), environmental (extreme weather conditions) and institutional (CAP support schemes, bureaucracy). In terms of social challenges perceived both by farmers and by farm households the crucial one is the unattractiveness of agriculture, both due to its social status, as well as perception of relatively lower income (at least when small and medium farming is concerned).

13.3.2 Present and past challenges for the farming system

The most influential current challenges outlined through the **ResAT** analysis are economic, environmental and social. In particular, they are the following:

Economic: price fluctuations, labor shortage, Russian embargo.

Environmental: extreme weather phenomena (especially droughts, floods), pests.

Social: low level of social trust among farmers hindering cooperation, changes in consumer preferences.

Institutional: overregulation and bureaucracy (they are limiting the activities instead of supporting them and opening new opportunities), lack of long-term vision (the aim is to sustain the status quo), low utilization of insurance possibilities.

Policy interviews were conducted with twenty people. Among the respondents, there were nine farmers, including two involved in ecological farming, four advisors, two sons of farmers, two public administration officials, one land tenant, one representative of the Local Action Group, and one supplier. According to these interviews the main challenges for the Polish fruit and vegetable farming system are related to income and fair prices, lack of workforce, weather events and climate change, market and competition, input and maintenance prices, water supply, horizontal and vertical collaboration, farm succession and plant diseases.

FoPIA-SURE-Farm enabled to reveal a substantial range of challenges faced by the horticulture farming system in Mazovian case study area of Poland. Discussion throughout the FoPIA-SURE-Farm workshop enabled verification of primary hypotheses voiced by the IRWiR PAN researchers based on literature analysis and aided in clarification of key challenges faced by the farming system. According to the gathered information it is possible to state that economic challenges are perceived by the stakeholders as having the most influence. Among these are the fluctuations of prices of agricultural products, which have been rather decreasing over the past decade leading to smaller profit margin received by the farmers. In case of particular products (e.g. such as analyzed black currants) the price did in fact gradually dropped nearly to the level of total costs spent by the farmers. Other are the weak competition arising from underdeveloped horizontal cooperation and weak organization of soft fruits market compared to other markets (milk or meat). Among the environmental challenges are the extreme weather conditions, decrease in the content of organic matter in soils, shortage of water resources, threat of erosion. Often voiced out institutional challenges clearly have the third place as the stakeholders of all groups have been emphasizing variability of laws and regulations, changes of requirements regarding emissions of pollutants and animal welfare, lack of institutional support for horizontal cooperation between farmers. Shortcomings of the CAP approach to support of farms has been pointed out several times as well. Among the social challenges are the following: periodical lack of seasonal workers, social resistance against large-scale animal farms, historical fragmentation of Polish agriculture in Southern and Eastern regions, lack of defined farm successors.

13.3.3 Concluding remarks on challenges

Table 13.1 synthesizes the challenges faced by the farmers, farm households, and the horticulture farming system of the Mazovian case study area in Poland in general. Clear similarities are visible across methods used, as economic and environmental challenges prevail in all of them, also delivering similar description of existing circumstances and risks faced by aforementioned subjects.

Table 13.1. Summary of challenges across methods (table continues over two pages).

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Horticulture and permanent crops farms	5.2 (most relevant)	5.2	3.8 (least relevant)	4.3
	Shocks	Learning interviews	Weather conditions	-	-	-
		Demographic interviews	Extreme weather conditions			
	Long-term stresses	Learning interviews	Intensification of pest appearance, fluctuations in yield	Price fluctuations, decrease of profitability and increase of production inputs	Problems with potential farm successors	Bureaucracy, regulations on plant protection, inefficient auctions system for supply of public facilities, embargo on exports to Russian markets, land market restrictions
		Demographic interviews	-	High volatility, low profitability, unfavorable output/input price ratios	Unattractiveness of agriculture	CAP support schemes, bureaucracy
Households	Shocks	Demographic interviews	-	-	-	-
	Long-term stresses	Demographic interviews	-	Lack of economic incentives in terms of income	Unattractiveness of agriculture due to hardship of work and low quality of services and life in rural areas	-
Farming system	Shocks	ReSAT	Extreme weather phenomena (especially droughts, floods)	-	-	-
		Policy interviews	Weather events	-	-	-
	Long-term stresses	ReSAT	Pests	Price fluctuations, labor shortage, Russian embargo	Low level of social trust among farmers hindering cooperation, changes in consumer preferences	Overregulation and bureaucracy, lack of long-term vision (the aim is to sustain the status quo), low utilization of insurance possibilities
		Policy interviews	Plant diseases, climate change	Income and fair prices, market and competition, increasing input and maintenance prices	Lack of workforce, farm succession	Collaboration (both horizontal and vertical)

			Environmental	Economic	Social	Institutional
Farming system (past challenges)	Shocks	FoPIA-SURE-Farm	Extreme weather conditions	Fluctuation of prices of agricultural products, weak competition arising from underdeveloped horizontal cooperation	Periodical lack of seasonal workers, social resistance against large-scale animal farms	Variability of laws and regulations, changes of requirements regarding emissions of pollutants and animal welfare
	Long-term stresses	FoPIA-SURE-Farm	Decrease in the content of organic matter in soils, shortage of water resources, threat of erosion	Weak organization of soft fruits market compared to other markets (milk or meat)	Historical fragmentation of Polish agriculture in Southern and Eastern regions, lack of defined farm successors	Lack of institutional support for horizontal cooperation between farmers

13.4 OPPORTUNITIES

13.4.1 Present opportunities for the farming system

During the FoPIA-SURE-Farm workshop discussion several opportunities have been clarified that are still feasible for the farming system. While the stakeholders themselves see the need of constant financial and technical support from the government and various state institutions, the key is the education and development of skills needed to implement the resilience strategies on the farm level. This can be achieved by consequent educational and training activities organized for farmers, which would not only aid them in technological issues, but transform the perception of their role and abilities from the “recipient” of private and public goods to their “initiator” and “supplier”. As the farming in Poland overall and in the particular farming system is greatly fragmented, one of the key directions to improve the resilience is the creation of producer groups, developing the agricultural infrastructure (in case of horticulture mainly concerning storage facilities with refrigeration), providing agricultural producers with advisory services to make the proper choices in the types of crops to grow.

13.4.2 Past opportunities for the farming system

FoPIA-SURE-Farm enabled to extract some of the past opportunities farming system has witnessed over the decades. While opportunities were not a key topic to discuss, during the group work on indicators and their historical development, as well as in all the other discussions during the workshop it was possible to outline several key opportunities voiced by stakeholders. First opportunity of the past decades was in the year 1989, when privatization of state assets has begun and liberalization of market relations were introduced. It is then when numerous farms have appeared, while being quite fragmented in the Mazovian case study area due to landscape and privatization peculiarities, still has enabled the forming of farms supplying the emerging markets. Next stage of opportunities have opened when process of accession of Poland to the EU has begun and financial support became available for modernization of entrepreneurial activities, including in the agriculture. This helped many farms to evolve and become substantial suppliers of agricultural products, just for the time of accession of Poland to the EU, which has taken away all obstacles to function on the enormous European market consisting of over 400 million consumers at that time (year 2004). Support for producer groups under the EU funding has been utilized in Poland in the second half of the 2000's on a large scale, enabling Polish horticulture farmers to unite and led to specialization of whole regions in particular types of fruits or vegetables. For example, region of Grójec (part of the Mazovian case study area) is often called the "biggest orchard of Europe".

13.5 FUNCTIONS

13.5.1 Farmers and farm households

Farm survey revealed that farmers from horticulture and permanent crops farms in Poland consider private functions as prevalent over the public ones (Figure 13.4). Among the particular functions ensuring a sufficient farm income was defined as most important followed by the delivery of high quality food products. The maintenance of natural resources and the provision of employment and good working conditions were ranked in the middle. The least important function selected was the delivery of bio-based resources (e.g. hemp, wood) to produce biomass and biofuels, also one of the lowest scores were received by such functions as ensuring the attractiveness of rural areas in terms of agro-tourism and residence, as well as ensuring animal welfare.

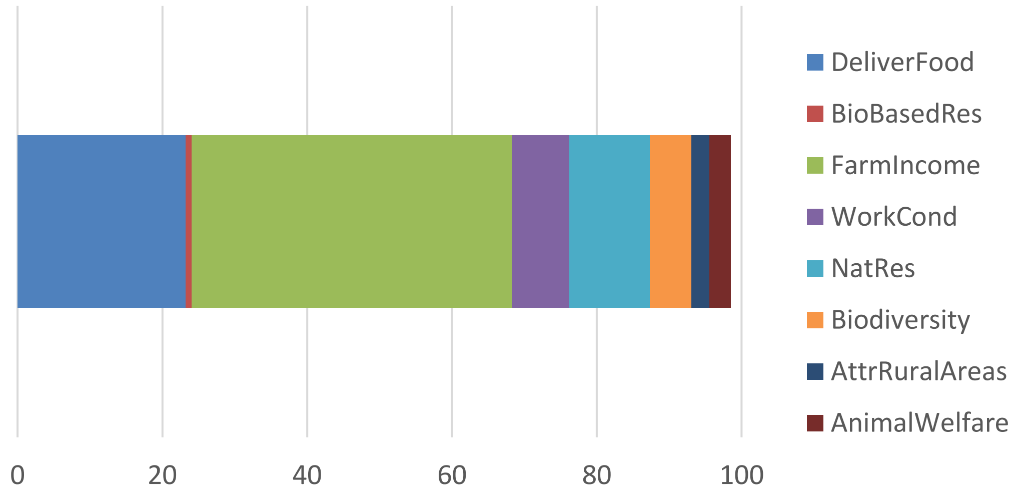


Figure 13.4. Essential functions (averages) of horticulture and permanent crops farms according to the farm survey in Poland.

The **learning interviews** have given very similar results, as the key functions voiced by the farmers were the farm income and quality of working conditions in rural areas, both being private functions. In terms of performance the farm income is evaluated poorly with a downward trend.

Similar results were obtained through **demographic interviews**, as the prices for farm outputs have been one of the most frequently occurring answer. Derived from this it is possible to synthesize that economic function, namely farm income is the key issue in the perception of farm owner, as well as their households. It directly influences the attractiveness of agricultural activity and the household's perception of involvement in the farming activities (this concerns potential successors, thus tackling social issues as well).

13.5.2 Farming system

The FoPIA-SURE-Farm workshop gave insights into stakeholders' perceptions regarding essential functions of the farming system. Three groups of stakeholders have been outlined during the Polish FoPIA-SURE-Farm workshop, namely *Farmer*, *Government* and *Other* (the latter being a mix of NGO representatives, researchers, veterinary professionals). Based on overall stakeholders' opinions, the most important functions delivered by the farming system are the "Economic viability" and "Food production" (Figure 13.5). During the discussion it was also clear that economic issues, as the prices, income and costs are key factors in the farming system and have the strongest influence upon its actors. "Quality of life" scored third highest influence and was voiced out as the one function that is strictly connected to the previous two functions.

While all groups were homogenous concerning the high importance of the "Economic viability" and "Food production" functions, the farmers were the ones who focused on "Economic viability", while the "Food production" was chosen by such groups as *Other* and *Government*. The representatives of the *Other* and *Government* groups were also more willing to define higher importance of the public functions, including environmental protection. Therefore stakeholders representing these two groups were emphasizing the role of "Natural resources", "Biodiversity & habitat", "Animal health & welfare" compared to farmers. The *Government* group was the one that outlined the importance of "Bio-based resources" and "Attractiveness of the area" more than the other two groups of stakeholders.

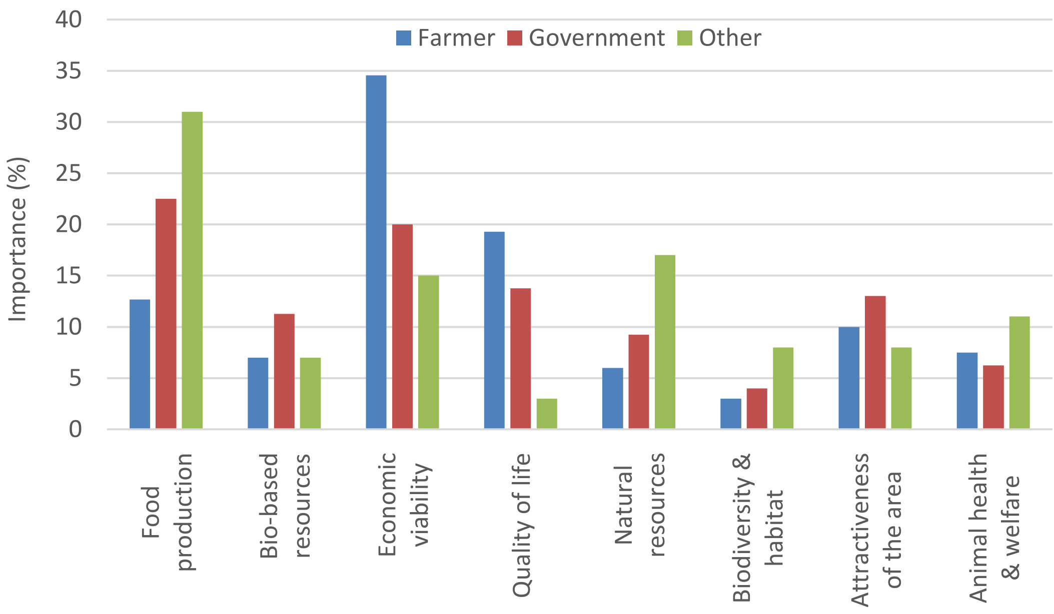


Figure 13.5. Essential functions in the horticulture farming system in Poland (aggregated by stakeholder group, 100 points needed to be divided over eight functions).

The top performing indicators were the "Share of fruit cultivation (% of sown area)" and the "Protected areas as % of total area", receiving the scores of 3.1, followed by "Concentration of air pollution" (2.9), "The number of bee colonies (pcs)" (2.8) and splitting the last top score of 2.6 were the "Quantity of common birds in the agricultural landscape and forest birds" and "Agritourism farms (number of units)"

(Figure 13.6). The stakeholders see rather good trends in changes of environmental protection, rural development in terms of ecological conditions.

While the groups of participants emphasizing these indicators were mostly *Government* and *Other*, the *Farmer* group has supported these statements as well, contributing to the positive scores of the most of environmental indicators.

The bottom-line of the analysis shows that even the indicators receiving the highest scores were still in the range from 2 (poorly performing) to 3 (not good not bad). The delivery of private goods in total was scored with an average of 2.1, yet the worst performing indicator was the “Price of NPK fertilizers (PLN/kg)”, followed by “Antibiotic consumption per livestock unit” (1.6).

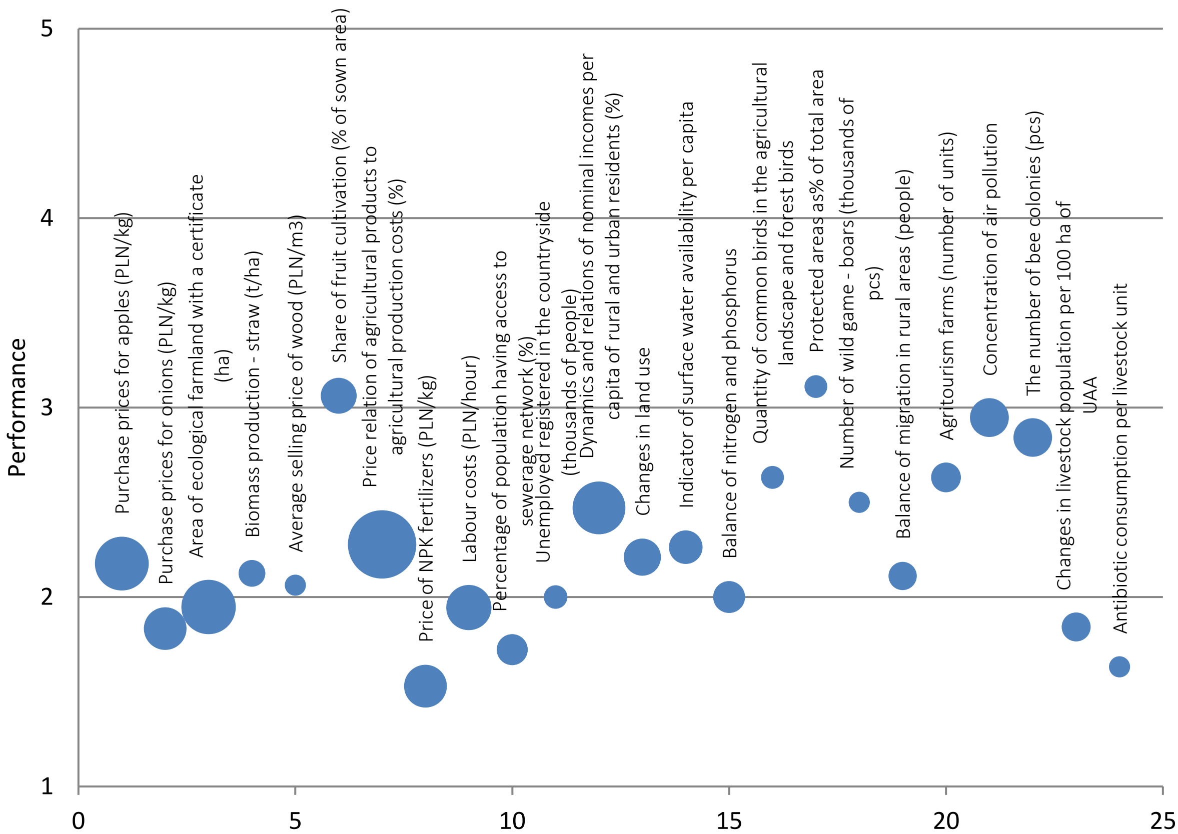


Figure 13.6. Performance of indicators in the horticulture farming system in Poland (from 1 to 5, while also indicating their importance by the size of the bubbles, relative to each other).

Overall, the horticulture farming system is poorly performing according to the key functions defined by the stakeholders (Figure 13.7). These functions outlined as having the highest importance are the “Economic viability” and “Food production”. Yet the best performing functions, although still performing at the level of below 3 out of 5 (defined as “not good not bad”) are the “Bio-based resources” and “Biodiversity”. Most opinions during the discussion supported these findings, as the participants were overall dissatisfied with economic situation and perceived the ongoing changes of environmental issues as rather positive.

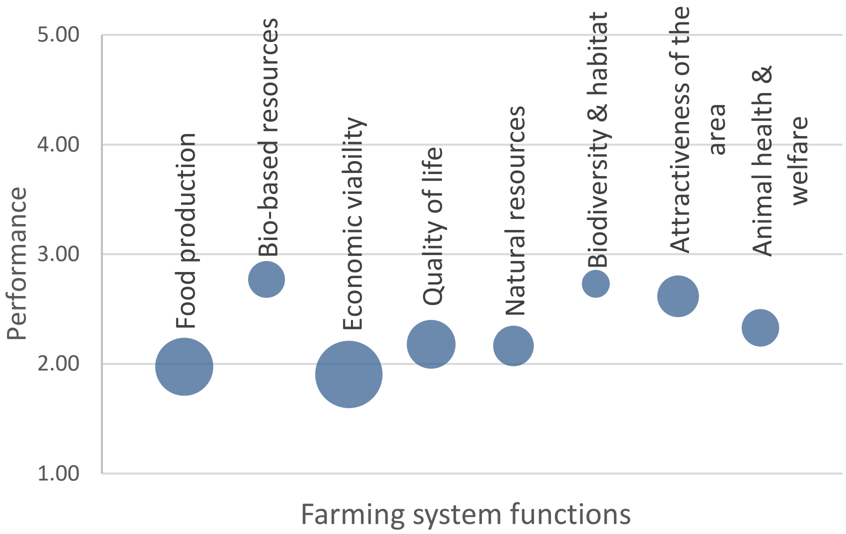


Figure 13.7. Performance of essential functions in the horticulture farming system in Poland (from 1 to 5, while also indicating their importance – size of the bubbles).

In the **focus group on risk management** strategies it was possible to evaluate the performance of essential functions. Thus delivering high-quality food products (one of the private functions) has been rated having a good performance, while maintaining natural resources in good condition (being one of public functions) has been rated as having medium performance.

The **ecosystem services assessment** shows that private goods provision score very low, all under 0.5 (Figure 13.8). The highest score belongs to the energy crop production, followed by the food crop production. Provision of public goods seems to be showing slightly better results, as the capacity to avoid soil erosion (top score of ca. 0.9) and water retention index lead the ranking, with equilibrium phosphorous concentration being third from the top (yet scoring only ca. 0.25) (Figure 13.9). All the other services are scored even lower, therefore having an insignificant impact.

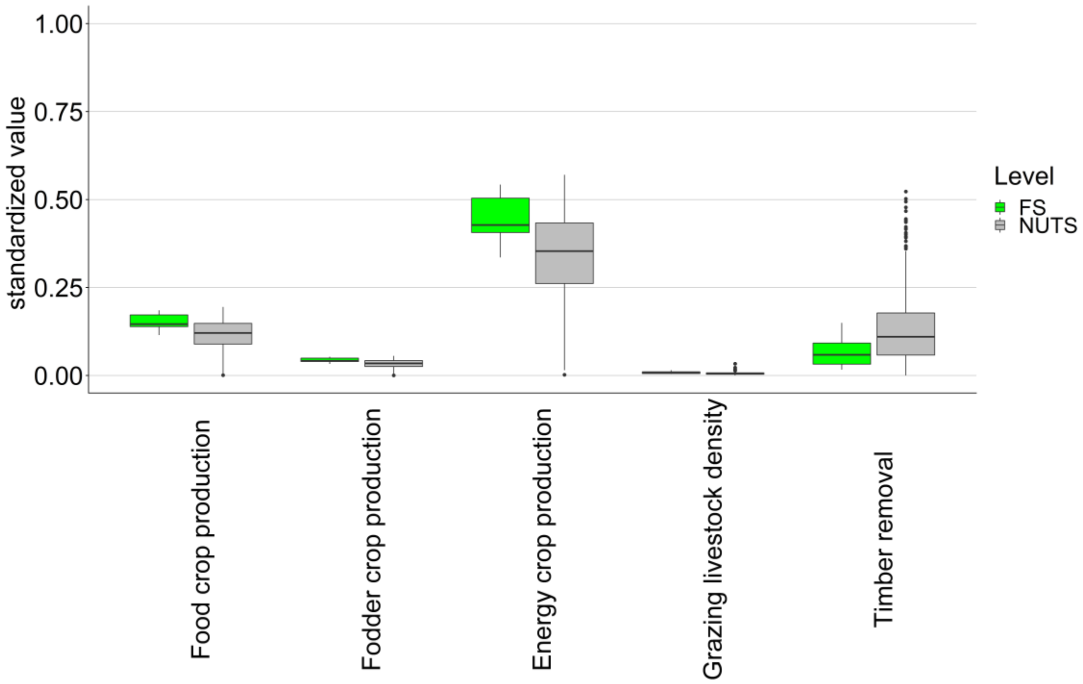


Figure 13.8. Current performance of ecosystem services related to private goods.

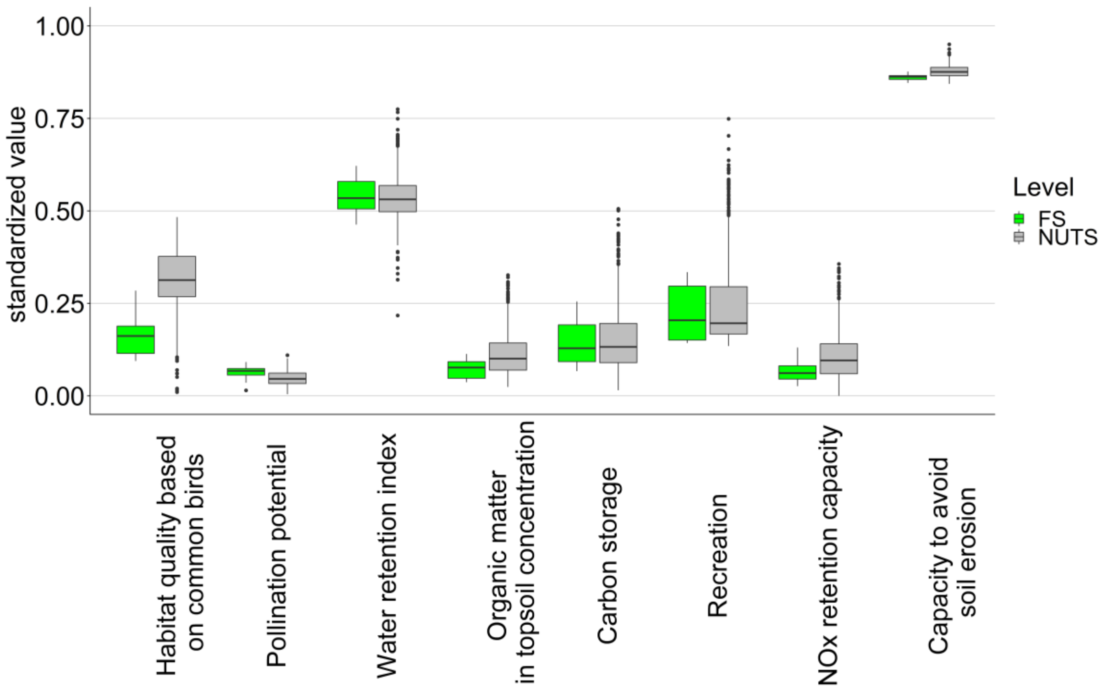


Figure 13.9. Current performance of ecosystem services related to public goods.

13.6 RESILIENCE CAPACITIES

13.6.1 Farmers and farm households

In the **farm survey**, farmers have rated all the resilience capacities at a similar level. Still, on average they have rated their transformability highest (3.8), then their robustness (3.7) and adaptability (3.6).

In the **learning interviews**, farmers indicated the following resilience capacities:

Robustness: Farms withstand the constant lack of available workers in the past years. Way of coping with the labour deficit is primarily by not gathering parts of harvest (e.g. letting apples rot on the trees), even though it leads to partial loss of profits. As there is no possible way to overcome this obstacle from the farmer's position, to many farmers it seems as the only possible solution.

Adaptability: Farms adapt to changing conditions by various activities, including: leasing part of their agricultural land to other farmers, new initiatives are being implemented in the farm (such as irrigation or planting of new plants), adjusting on-farm activities by expanding fruit trees production with vegetables production (case of several farms), adjusting by starting cultivation of less labor-intensive plants.

Transformability: Most farmers don't understand how to introduce big changes to their farm or primary activity, therefore they rely mostly on two previous capacities. One of the restricting factors voiced is the lack of financial resources, which unables possible diversification (which is percieved as requiring purchase of land and/or equipment).

In the **demographic interviews**, farmers indicated the following resilience capacities:

Robustness: In the Polish case study area and for the type of farms selected for research this resilicence capacity utilisation is typical, specially in case of farms with older owners. Interviews have proven the hypothesis that farms with several decades of background and same owners often tend to continue their activities is an unchanged pattern, or with only slight modifications. While the challenges arise, farms withstand them, yet even in case of decreasing profits or slight loss they continue their agricultural activities, as if there was no other option. This can be easily explained by the decreasing readiness to implement changes and take risks as the farm owner are ageing.

Adaptability: Some of the farms have stated ability to adapt to changing circumstances and implementation of measures aimed at modification of their agricultural and economic activities in order to meet arising challenges. For instance by looking for new markets, searching for possibilities of cooperation both horizontally and vertically, implementing improved farming practices such as investing in irrigation systems, diversification of crops.

Transformability: This resilience capacity seems to be the most difficult, as it requires ideas, readiness to diversify or change typical activity patterns, as well as investments and taking additional financial risks. Interviewed farmers seemed rather distressed about such transformation measures, key limiting factor seems to be their age. As far as farming households are concerned, possibilities of getting a job in the city as a measure to diversify household income is one of key directions, while this approach has a negative effect on potential farm succession, as in many cases employment in urban areas leads to migration and lack of willingness to return and manage the farm in future.

13.6.2 Farming system

During the FoPIA-SURE-Farm workshop, strategies' of the indicators "price of black currant", "price of raspberry", "price of sugar beet", and "biodiversity" and their contribution to resilience capacities have been assessed (Figure 13.10). Stakeholders in five groups talked about the challenges that are faced and will be faced in the future by the horticulture farming system in the case study region and for each challenge they identified specific strategies and proposed resilience indicators related to those strategies.

Robustness: the most supporting strategies are "Horizontal cooperation", "Vertical cooperation", "Insurance", "Marketing" and "State support". The cooperation strategies increase robustness through the system of compensation (if some farms are in trouble the other make up for them in the whole farming system). "Insurance" and "State support" create a buffer for the sector, besides in view of stakeholders the most welcome state support is in form of price stabilization by interventions at the market, which otherwise is very unstable.

Adaptability: the top supporting strategies are "Horizontal cooperation" and "Insurance", followed by "Enduring" and "State support" strategies. Cooperation forced some adaptation to standards of the collaboration (quantity of production, quality, timing) and the insurance was still a strong measure to adapt to changing environment. "Enduring" and "State support" were defined as having weak positive relationship. In particular with the "State support" it could be explained as actions towards enabling adaptability though CAP support, which subsidizes investments in new technologies and machines. On some strategies the stakeholders' opinions differed greatly, such was the case with the "Marketing". The ones analyzing the challenges faced by the production of black currants have noted the influence of "Marketing" among highest, while the total opposite situation concerned the producers of raspberries. In terms of insurance the key elaboration voiced out by the stakeholders is their expectation to receive compensation of insurance premiums from the state, therefore they expect actions in these terms rather than are willing to make efforts on their behalf. In terms of "State support", compensation of possible losses due to market price fluctuations is expected, in addition to usual CAP support.

Transformability: turned out to be the most controversial of the resilience capacities, as some of the strategies supporting this capacity received opposite evaluation, as was the case with diversification. Nevertheless, the most supportive strategy in case of Transformability is the "State support". "Diversification" scored opposite means in cases of strategies faced by production of black currant and sugar beet, in the first case highest possible and in latter – lowest possible score. In general diversification is trying new things, engaging in new activities (both economic and social), as well as experimenting with new actions/directions (e.g. new type of production, new activities on the farm). That brings both activity diversification and income diversification. However, similarly as in case of "Marketing" strategy for Robustness, Adaptability does not always support transformability, it can also hinder it. So it all depends, which challenge this strategy addresses. "Diversification" supports transformability when the challenge is concerning the Costs of production, however, when the challenge is Fluctuation of prices then this strategy actually hinders the Transformability. That is an interesting outcome, because costs of production (e.g. costs of inputs) are usually more stable over time so if they increase that is usually a long term trend. On the contrary, Fluctuation of output prices is more random and unpredictable. So "Diversification" seems to be good for transformability if it responses to long term unfavorable trends, otherwise it doesn't have time to be introduced before the challenge increases to full extent. One stakeholder said that changing production activity is time and money consuming, and he realized that he would come up with the same outcome if he does not do it just wait for reverse changes without any adjustments (utilizes Robustness approach).

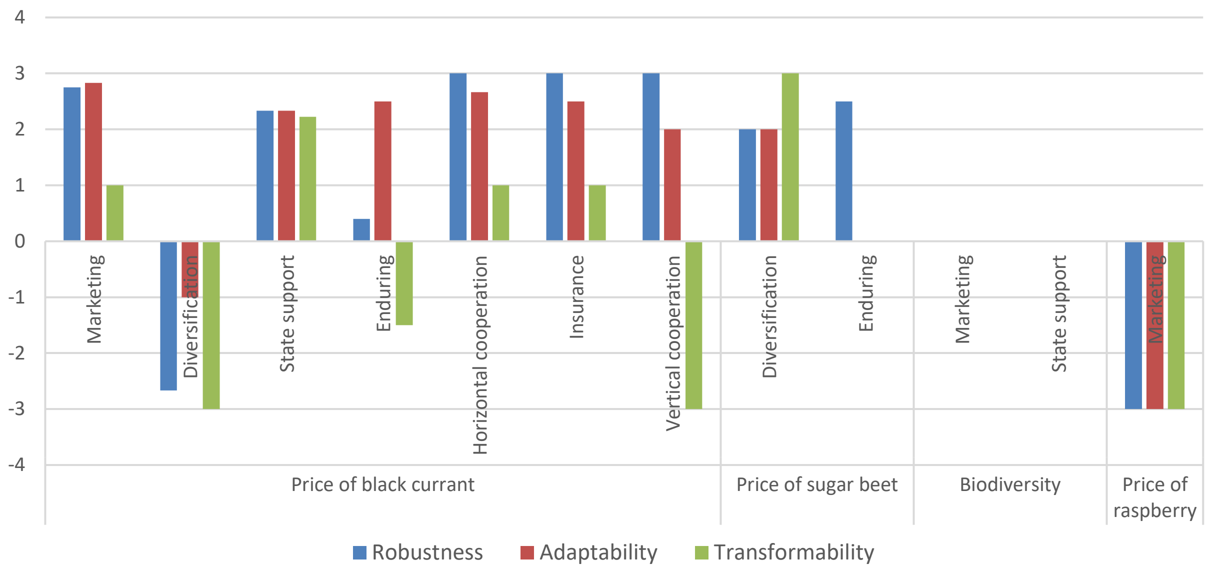


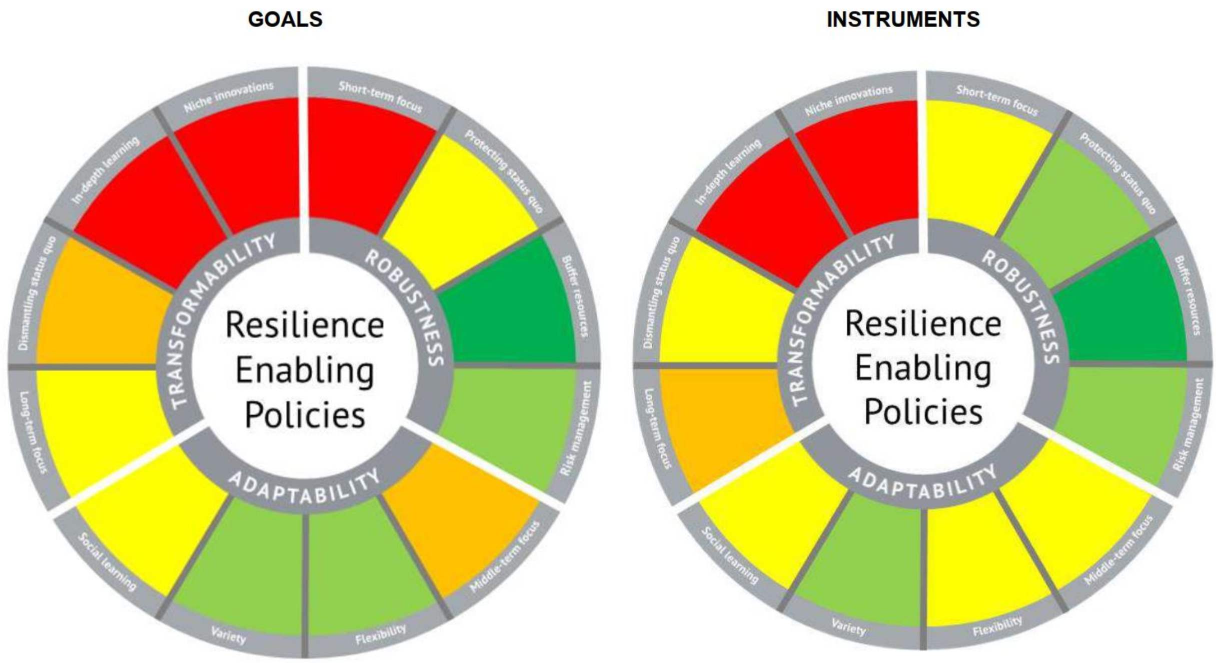
Figure 13.10. Effect of strategies on robustness, adaptability and transformability of the horticulture farming system in Poland (a 0 implies no relationship, a 1 or -1 a weak positive or negative relationship, a 2 or -2 an intermediate positive or negative relationship, and a 3 or -3 is a strong positive or negative relationship).

The **ResAT** analysis evalutes the resilience capacities of the system as follows (Figure 13.11):

Robustness: The CAP goals usually relate to time scope longer than one year, so they do not enable short term focus. The only short term goal expressed in analysed documents is the intention of mitigating risks related to uncertainty of markets and environmental risks (EC, 2017b). Protection of status quo is fairly enabled. Ministry of Agriculture and Rural Development of Poland (MRiRW) is declaring keeping the model of agriculture based on family farms, by ensuring special support. The goals of CAP are enabling for the development of buffer resources. Farmers are rewarded for their services by stable income support. Also other modes of managing risks are enabled by the CAP goals. Mutual funds and insurance schemes allow farmers to respond better to market and price instabilities. MRiRW aims to stabilize the main agricultural markets, and increase the intake of farm facilities and yields insurance.

Adaptability: The CAP goals slightly enable middle-long-term focus, although goals usually relate to long time scope. Few of them have middle-term focus, such as measures for encouraging potential new entrants to take up farming. The CAP goals enable flexibility. Member States can design their own multi-annual programs in response to needs of their rural areas on the basis of the menu of measures available at the EU level. The new rules of the second pillar are more flexible than in the previous programming periods. Variety and tailor-made responses are enabled by the CAP goals. The Member States can design thematic sub-programs, to give special attention to issues such as young farmers, small farms, mountain areas, women in rural areas, climate change, biodiversity or short supply chains. Social learning is enabled fairly. There are goals of creating knowledge-based agriculture and strengthening advisory services, but the social learning is mostly an additional goal to other priorities.

Transformability: The focus on the long term is fairly enabled by the CAP goals. Member States have the responsibility to set out future strategies for the agricultural sectors, which will ensure their efficiency, competitiveness and sustainability in the long-term. However, most of those goals are not specific. The dismantling of incentives that support the status quo is only slightly enabled by the CAP goals, because the key characteristics of the CAP remained untouched by the reform. In the examined documents there is no expressed will of dismantling such incentives. In-depth learning is not enabled by the policy goals. The goals related to learning do not concern changes in paradigms or radically new frames. The enhancement and acceleration of niche innovations is not enabled by the CAP goals.



Question: To what extent do the policy's goals and instruments enable or constrain the characteristic?		
Answers: enabling	**Answers: constraining**	**Score (+ colour)**
Not clear		**0** (White)
Not enabling	Very constraining	**1** (Red)
Slightly enabling	Constraining	**2** (Orange)
Fairly enabling	Fairly constraining	**3** (Yellow)
Enabling	Slightly constraining	**4** (Light green)
Very enabling	Not constraining	**5** (Dark green)

Figure 13.11. Degree into which policy goals and instruments enable resilience.

Policy interviews have revealed some information about the resilience capacities of the farming system as well. Thus **robustness** is said to be having the highest support of the respondents and primarily includes measures towards protecting status quo and buffer resources. **Adaptability** is widely used and its key measures include diversification of non-agricultural and agricultural practices, intensifying and upscaling of farming business, reaching out to farming systems actors, anticipating events, trying new selling practices, innovations, additional income and taking out insurances. Scoring lowest in the interviews is the **transformability**, as it requires long-term focus and in-depth learning.

13.6.3 Concluding remarks on resilience capacities

At farm and farmers level, all three resilience capacities are evaluated at similar level however, transformability is the highest followed by robustness and adaptability. The fact that robustness and adaptability are scored lower by farmers can be explained to some extent by the fact that this sector is least supported by CAP or public state of all sectors. Because these are small farms they have overall low amount of direct payments and their products do not benefit from public interventions (such as price guarantee or intervention purchase) so the farmers mostly need to either adapt or transform to the challenges.

At system level, the resilience capacities are assessed from low to moderate. In contrast to farm level, there is relatively high capacity assessed for buffer resources, and relatively low capacity to transform. Current policy configurations seem to fairly foster robustness, but neglects transformability.

13.7 RESILIENCE ATTRIBUTES

13.7.1 Farmers and farm households

During the **learning interviews** some of the issues concerning attributes were tackled, which allowed the researchers to extract and group them according to the type of their influence. Attributes that are perceived as enhancing include acquiring knowledge from various sources (advisory services, journals, learning trips to the Institute of horticulture and experimental fruit farms, also self-learning), and constraining attributes include the lack of successors that stop farm development or even lead to gradual decrease of activities, also withdrawal of plant protection products is seen as limitation to farm resilience.

Similar is possible in case of **demographic interviews**, which have enabled to extract such enhancing resilience attributes from the cooperation (primarily between farms). As far as the farming households are concerned, several resilience attributes have been defined having adverse effects. The enhancing attributes are the 1) family traditions and 2) difficulties in finding work outside agriculture (forcing the household members to stay and aid in farm activities), while the constraining attributes are "being ashamed to be a farmer" or relatively lower income levels in agriculture compared to other sectors.

13.7.2 Farming system

Based on **FoPIA-SURE-Farm**, overall performance of provided 13 resilience attributes was assessed by stakeholders as very low, e.g. average score was 1.96 (on scale of 1 to 5, where 1 means not at all and 5 means very much) with most attributes being scored between 1 and 2. The best performing attributes (scored above 2) were on the first place: "Production coupled with local and natural capital" (3.0), on the second place: "Spatial and temporal heterogeneity (farm types)" and "Socially self-organized" (both scored 2.29) and on the third place "Functional diversity" (2.27).

It was assessed also how the attributes relate to three resilience capacities (Figure 13.12). That effect was assessed by the stakeholders on a scale from -3 to +3 where sign shows the direction of effect and the number explains the strength (1 weak to 3 strong, 0 meaning no effect). Generally they gave quite low scores for the effects which was related partially to currently bad economic situation in the sector. They perceived that the highest effect of attributes was on **Robustness** (average score 0.9), then lesser on **Adaptability** (score 0.8) and the least on **Transformability** (score 0.5).

Robustness: Attributes which are considered to have the strongest effect on the robustness of the farming system are "Coupled with local and natural capital (production)", "Supports rural life", "Socially self-organized", "Farm type - spatial and temporal heterogeneity", "Infrastructure for innovation".

Adaptability: All the five attributes which are ranking highest for robustness also show among the best performances regarding the adaptability of the system. The only exception is the attribute "Functional diversity", which is estimated to contribute most to the adaptability while ranging in the middle when it comes to the assessment of robustness.

Transformability: The most positive effect would have the "Functional diversity", "Response diversity" and "Infrastructure for innovation". It is important for transformability to be able to diversify and also to implement innovations. On the contrary there are quite a few attributes which would negatively affect transformability, such as: "Reasonably profitable", "Diverse policies", "Legislation coupled with local and natural capital". These are attributes which lower incentives for transformation of the system towards better resilience.

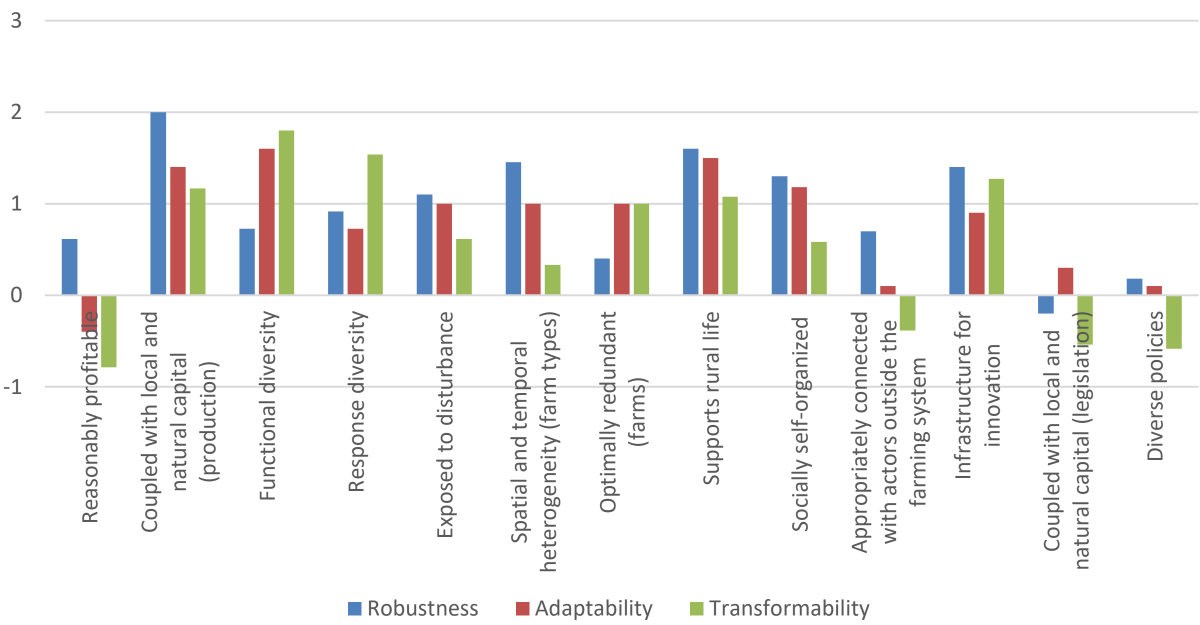


Figure 13.12. Perceived effect of attribute on robustness, adaptability and transformability (a 0 implies no relationship, a 1 a weak relationship, a 2 a relationship of intermediate strength, and a 3 is a strong relationship).

According to the participants of the **FoPIA-SURE-Farm** workshop, all attributes are applied in a small to moderate extent in the Mazovian case study area (Figure 13.13). As for 5 resilience principles - diversity, openness, tightness of feedback, system reserves and modularity - the highest scored attribute "Production coupled…" refers to **system reserves**. The next one, "Spatial… heterogeneity" is in line with

modularity while the other equally scored "Socially self-organized" is in line with **tightness of feedback** – as there exist fruit and vegetable producers groups, so there is connection within and outside of the system. Quite well represented in the system was **diversity** represented by "Functional diversity" (2.27) and Diverse policies (2.0). Openness was weak in the horticulture system, especially if represented by Exposed to disturbance (the lowest score of all attributes, 1.40) and slightly better represented by Infrastructure for innovation (2.0).

As for resilience attributes in relation to four SURE-Farm processes – agricultural production, risk management, farm demographics, governance – the top 4 attributes relate to all those four processes, e.g.: 1) "Production coupled" relate to agricultural production; 2) "Spatial … heterogeneity" to demographics, 3) "Socially self-organized" to governance and 4) "Functional diversity" to risk management. So it seems that system quite equally distributes its attributes among processes, at least those most highly scored.

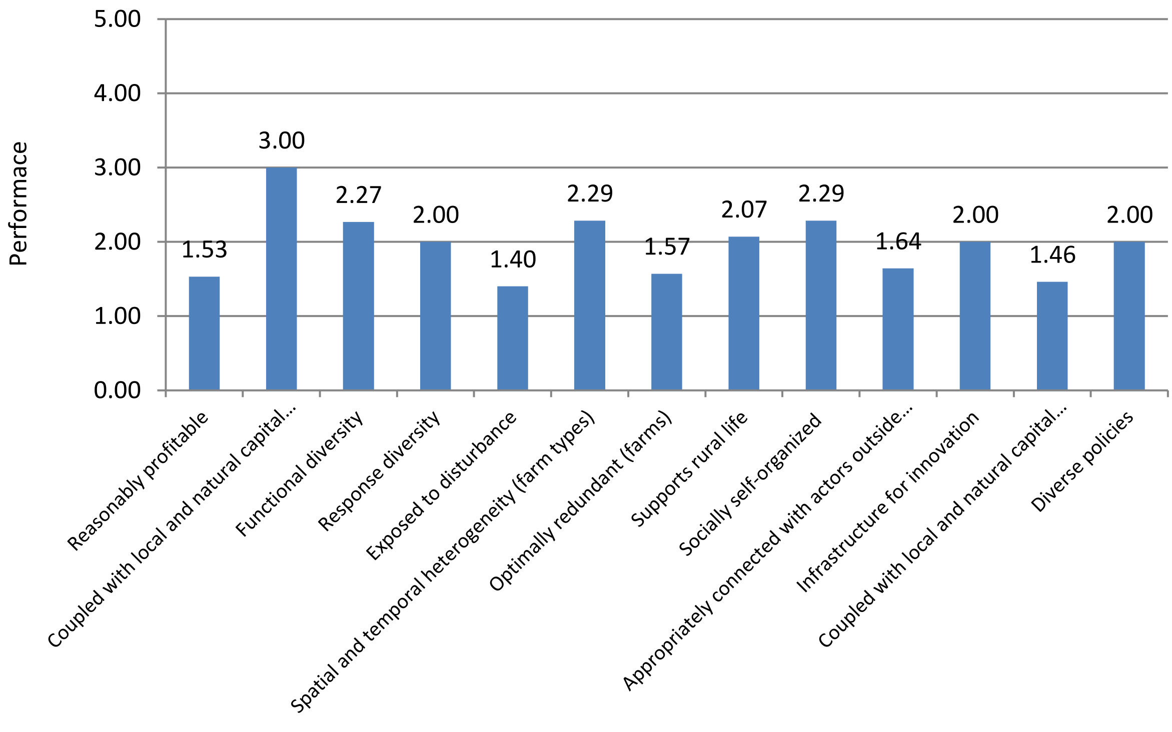


Figure 13.13. Current performance level of resilience attributes (performance is scored as 1 = not at all, 2 = small extent, 3 = moderate extent, 4 = big extent, 5 = very big extent).

13.7.3 Concluding remarks on attributes

The most important attributes for the resilience of the Polish horticulture family-farming system are (Table 13.2):

- 1. Reasonably profitable, 2. Socially self-organized and 3. Spatial and temporal heterogeneity (farm types), 4. Supports rural life, 5. Coupled with local and natural capital (production).

However, the extent to which the attributes actually are present differ:

- The most applicable is: "Coupled with local and natural capital (production)",
- The least applicable is: "Reasonably profitable".

In division by groups of stakeholders, the best performing attributes were:

- For farmers: "Coupled with local and natural capital (production)",
- For Government officials: "Spatial and temporal heterogeneity (farm types)",
- For Others: "Functional diversity".

The most positive contributions of attributes by resilience capacities were:

- For Robustness: Coupled with local and natural capital (production),
- For Adaptability: Socially self-organized,
- For Transformability: Response diversity.

Table 13.2. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Introduce biological substances which do not affect the environment (RM)	Response diversity low (policy) (G)	Diversified production (RM) Introduce agrotechnics to eliminate the use of herbicides (RM) Functional diversity is moderate (farmers) (AP)	
Openness	Increasing transfer of knowledge (farmers-advisors-producers) (FD)		Being in contact with the largest amount of information providers possible (RM)	Low openness for cooperation among farmers (FD)
Tightness of feedbacks	Maximally simplify procedures and regulations (RM)	Policy and institutional overregulation (RM) Policy overregulation (G)	Not much support from CAP so no attachment to status quo (G)	High dependence on contractors due to perishable products (AP)
System reserves	Increasing transfer of knowledge (farmers-advisors-producers) (RM) Facilitating the acquisition and lease of land, especially by young farmers (RM)	Too much bureaucracy when employing seasonal workers (RM)	Production is moderately coupled with local and natural capital (AP)	Low support by policy of both income (small CAP support) and insurance policy (G)
Modularity	Farmer can introduce cost flexibility by receiving information from other sources,		Relative heterogeneity is moderate, and it is evaluated better by government	Relative heterogeneity of is moderate, and it is evaluated better by

	confronting them with his own possibilities and needs. Example: financial sector + farmer; adviser sector + farmer (RM)		officials than farmers (FD, AP)	government officials than farmers (FD, AP)

13.8 ADAPTIVE CYCLE

For Poland and its agriculture the year 1989 was a ground-breaking moment, when country has won its total independence from the USSR and started the process of reforms and transformations in all possible areas of life. Until 1989, when the privatization processes began, most of agricultural activities were conducted in state-owned farms (państwowe gospodarstwo rolne, PGR), where the majority of rural inhabitants four decades ago were urged/forced to enter and to contribute their lands and assets. These state-owned farms were inefficient, employing more people than necessary, as such employment was nearly the only source of income in rural areas. At that time, the system had lots of buffer resources (in terms of labor, land, environmental amenities, etc.) and there were no alternative jobs for farmers outside of agriculture (as they had low education and there was overall high unemployment in the economy). However, there was good demography in rural areas (e.g. due to high fertility). Now however, the situation has changed and many processes that the system faces transformed, or even reversed. For example, the situation at the labor market has reversed – there is almost no unemployment and high shortage of the workers in sectors beyond agriculture. Besides, over the time, the farmers invested a lot in education of their children (also thanks to CAP) so the young generation has much better opportunities to choose good jobs, both in Poland and abroad. The introduction of CAP also helped to reverse the falling trend of support for agriculture and resulted in significant increase in income of agricultural households.

All in all, in the Polish farming system the adaptive cycles show very different phases for each of the main adaptive agricultural processes, so the average is somewhere in the middle of all the phases (Figure 13.14).

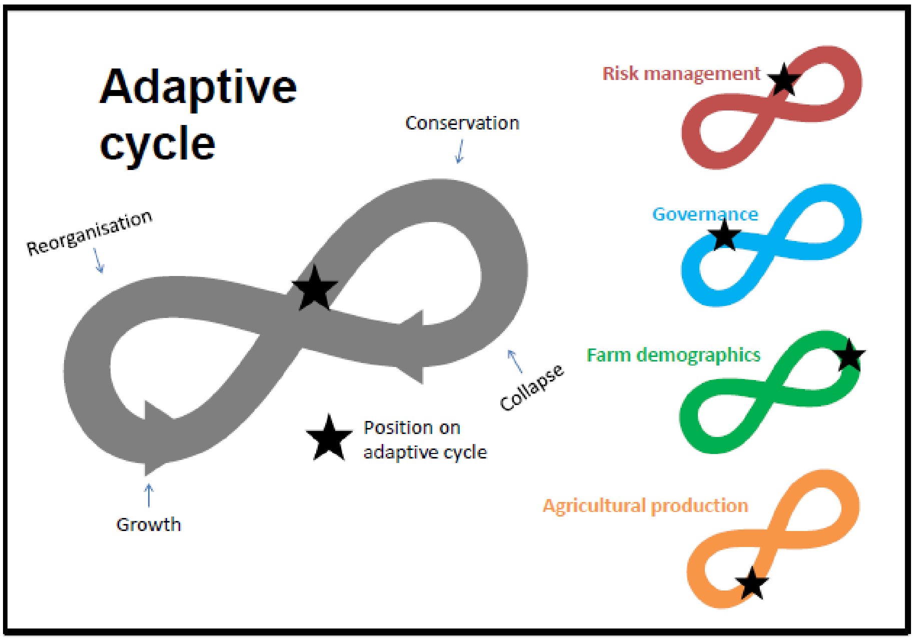


Figure 13.14. Positioning the Polish horticulture farming system on the adaptive cycle of processes in agriculture.

Concerning risk management, it is in advanced **growing phase** but still **far from conservation**. The system develops new management strategies but farmers are still hesitant with adapting them. For example, insurance for extreme weather events are still not so common among farmers although the offer of the private and public insurance tools increases. Some strategies are being implemented to mitigate the negative consequences of droughts and to promote good water management. However, many risk management practices are still not developed (e.g. towards environmental risks, price changes risks, etc.), but these can develop over time.

Concerning governance, it seems to be at the **reorganization phase**. The ResAT analysis reveals that the policies seem to have more ambitious goals than instruments to support adaptability and transformability. The advancement in reorganization of the policy is visible but the learning and demographic interviews reveal that the farmers perceive the changes as not sufficient and sometimes too constraining for their activities. They complained on over-regulation and bureaucracy as well as on lack of long-term vision. However, from the policy makers point of view it seems logical to introduce high demands (so to avoid abuse of the funds) and if they realize they are too tight (the uptake from beneficiaries is low) then they release the conditions. That is why this governance adaptive cycle seems under reorganization as a result of learning processes from both sides – policy makers and beneficiaries.

Farm demographics cycle, in our perception, just passed the **conservation phase** and moves towards the collapse. It means that from statistical point of view the demographic situation in this system is relatively good (in Polish agriculture sector there is the highest percentage of young farmers in the EU), but that is to change quickly over the next years. The signals from learning and demographic interviews are very clear that there is already a problem with farm successors, high emigration of young people to other countries or switch to other occupations and at the same time low availability of foreign qualified workers for the system in Poland. The important factor influencing deteriorating demographics in rural areas is that the system fails to provide one of its main functions that is attractiveness of rural areas in term of residence. The living conditions, hard and risky occupation discourages young people and new entrants to the system.

Concerning agricultural production, in researchers perception it is at a fast growth phase and it still has potential for further development if it manages to improve its overall resilience. The statistics show development of the horticulture sector, especially apple producers are very competitive and expanding further at the EU markets. However, it is important to mention that apart from the small family farms (our case study system) there co-exist large corporate farms, which contribute to the overall success for that sector.

13.9 STRATEGIES

Based on WP4 policy interviews and risk management focus group, the identified future strategies (Table 13.3) are mostly related to governance and they are:

- more flexibility of policies,
- increase of involving stakeholders in policy making,
- increase in efficiency of insurance and other risk-management systems.

One of the key issues needed for effective development and implementation of strategies is the transformation of farmers' attitude from simple subjects of the farming system to active and participatory attitude. While there are numerous challenges that one particular farmer has no influence upon, yet in order for the farming system to develop, the level of its actors' awareness and willingness to act, search for solutions and cooperation is crucial. Strategies for the future should target aspects of robustness, adaptability and transformability in order to increase its overall resilience. However, the focus should be on a participatory design of strategies which allows the system to sustainably cope with major future challenges, such as the climate change, increased global competition, or an ageing society. Table 13.3 summarizes future strategies mentioned per process.

Table 13.3. Future strategies per process.

Process	Future strategies
Agricultural production	- Use of biologically active substances which are not affecting the environment - Introduction of agro technologies which limit the use of herbicides - Participation in shows, seminars, demonstrations of farms to learn about new technologies, varieties etc.
Farm demographics	- Stimulating succession via easier access to land - Improving quality of life in rural areas (for family, children, old people) - Policies oriented on earlier retirement - Increasing work mobility for rural families (spouses' distant work while living on farm)
Governance	- More flexibility of policies - Increase of involving stakeholders in policy making - Ease the bureaucratic procedures of hiring seasonal workers from abroad. - Increasing efficiency of insurance and other risk-management systems - Publishing a black list of unethical suppliers.
Risk management	- Economic trainings for farmers. - Introduction of a direct information exchange platform so farmers know what clients/consumers expect - Diversification of agriculture production (suiting varieties to changing conditions)

13.10 CONCLUSION

The small family farming horticulture system in Mazovian case study area faces many challenges where some are inherited from the communist past (e.g. low cooperation due to farmers' distrust), other are related to new situation of the free market economy (e.g. large price fluctuations), another are related to becoming part of EU and participating in CAP (e.g. overregulation and bureaucracy) yet some other come from global trends (e.g. climate change and labor shortage due to migration trends).

In addition to changes in challenges, the system itself has its own dynamics depicted in adaptive cycle. It shows the phase of growth for agricultural production and management risks, the phase of reorganization for governance (policies and structures) and the edge of conservation for farm demographics.

The ability of system to react to the challenges and keep the provision of basic functions depends on its resilience capacities. Robustness and adaptability are the key resilience capacities at the current farming system's development stage, and they are mostly supported by policy. Transformability is appreciated by farmers and farm households as well, since they do not rely on the public support so much (as the least supported sector under CAP) and are used to cope without public support, still they expect market regulations from the state to be able to increase their adaptation and transformation capabilities.

14 CASE STUDY ROMANIA

Camelia Gavrilescu

14.1 ABSTRACT

The farming system in the Romanian Nord-Est region consists of small mixed farms, with main production activities crops, livestock and grassland. An important characteristic is the high heterogeneity across farm types. The main challenges consist of poor integration in the agri-food chains, dependence of off-farm incomes, climate change, increased frequency of extreme weather events, lack of available labor due to emigration of young people, and constantly changing policies and regulations. The most important functions of the farming system are: delivering high quality products and ensuring a sufficient farm income (as private goods), and provision of animal welfare and preserving natural resources (as public goods). Overall, the resilience of the system is moderate to high. There is a relatively high capacity to transform and adapt, but a relatively low capacity to keep the status quo. Current policy instruments support more adaptability and less transformability, while farms demonstrate adaptability and transformability and less robustness. The attributes enhancing resilience are moderate to high: diversity and modularity are high, while system reserves and openness are moderate to high. Tightness of feedbacks is the only resilience attribute that is low. Future strategies identified consist of risk management and financial instruments better adapted to the needs of small farms, more stable policies and fiscal regulations, an improved consultancy system, facilities and incentives for establishing farmers' cooperatives, easier access to markets and finance for new farmers or successors, continuous training of active farmers, development of organic production, diversification, and, last but not least, agricultural production increase through new technologies, new crops, better varieties, hybrids and animal breeds. Figure 14.1 provides a synthesis of results of methods to assess current resilience of the small mixed farming system.

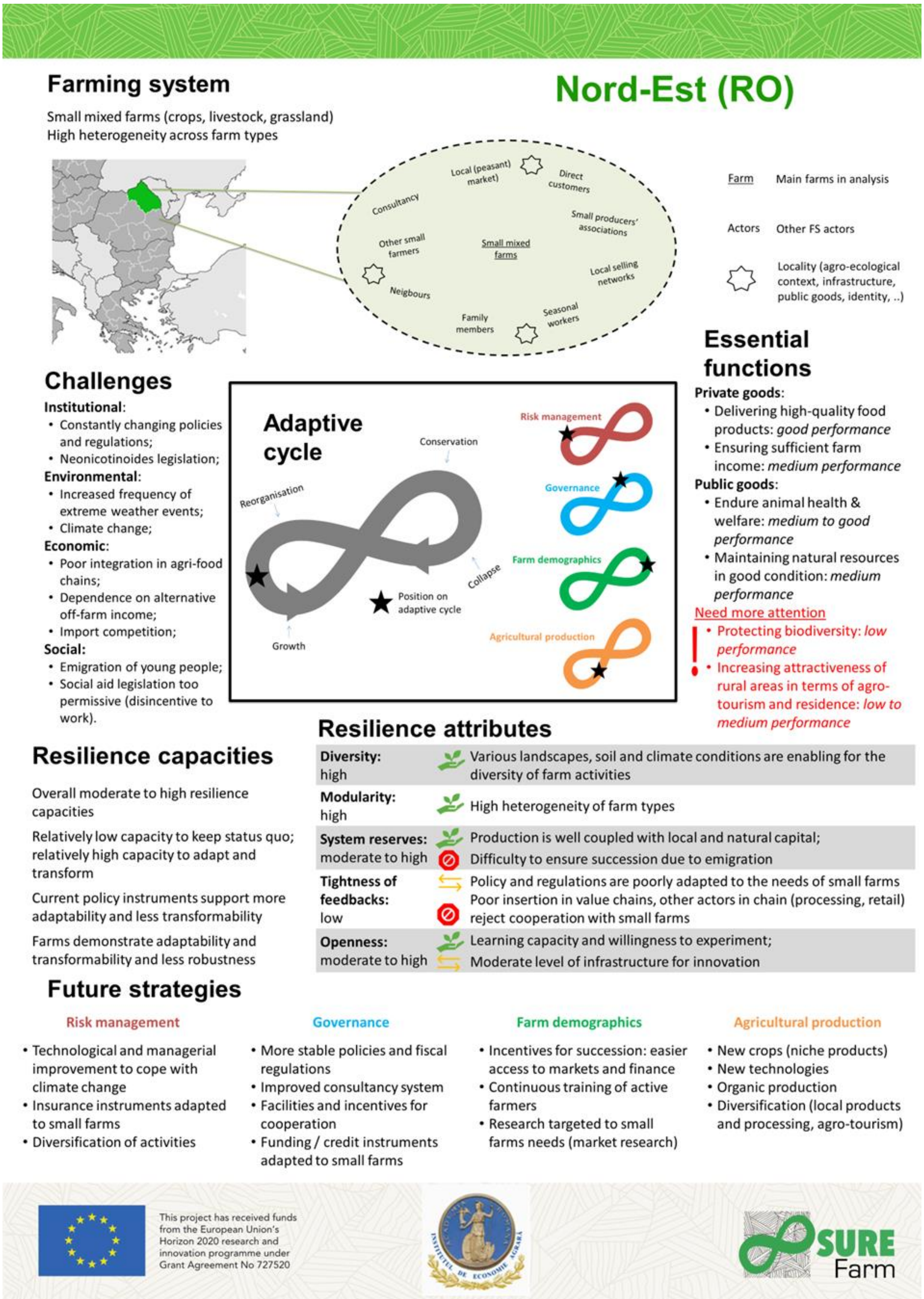


Figure 14.1. Factsheet synthesizing resilience of the current faming system in the Nord-Est region of Romania.

14.2 FARMING SYSTEM

The case study in Romania consists of small-size, mixed family farms in the Nord-Est region (NUTS2 area RO21). At NUTS 3 level it is composed of 6 regions (counties): Bacău (RO211), Botoșani (RO212), Iași (RO213), Neamţ (RO214), Suceava (RO215) and Vaslui RO 216). The studied area is traditionally dominated by small mixed farms (with both utilized agricultural area and livestock), which are generally family run (Bohatereț et al., 2018; Brumă et al., 2017). The last Farm Structural Survey (National Institute of Statistics (NIS), 2016) shows that in the Nord-Est region, 77% of the farms are mixed farms (~ 555,400). In terms of utilized agricultural area (UAA), 98% of the farms in the region have less than 10 ha, 95% less than 5 ha, and 56% less than 1 ha (the latter are not eligible for CAP support). The main crops grown in the region are maize, green fodder, wheat, and sunflower, while the livestock is composed of bovines (mostly dairy cows), poultry, sheep, pigs, and horses for transport purposes. A more recent development in the region is the intensification of bee farming.

These very small farms are the result of the farmland restitution policy in early 1990s, which, after the dismantling of the production cooperatives of Soviet type, recreated a category of small peasant household farms, doomed to survival through the farming activity oriented to on-farm consumption. In about 90% of the mixed farms from the Nord Est Region more than 50% of the final production is consumed on-farm. The small land areas into ownership and the incomes obtained mostly under the form of products for self-consumption have not allowed the acquisition of high performant equipment or the expansion or specialization of farms.

The type of challenges the studied farming system (FS) is facing is largely influenced by the particular identity of the system, such as a relatively poor economic performance and poor insertion in the value chains. Other challenges are related to extreme weather events (frequent droughts) and lack of available labour due to migration to towns or abroad. The key actors are also specific – one can notice a rather low presence of large companies (input suppliers, wholesalers, retailers, banks) which are not willing to work with small farmers.

The main actors identified in the inner circle of the case-study farming system in the FoPIA-SURE-Farm workshop are (Figure 14.2): farmer's family members, neighbors, other small farmers, local (peasant) markets, direct customers, small producers' associations, local selling networks; they are influencing farms, and, conversely, farms also influence these actors. Stakeholder discussion led to the inclusion of some more actors influencing the farming system (FS), but which are not influenced by it: cereal traders and wholesale markets, as well as the EU policy makers.

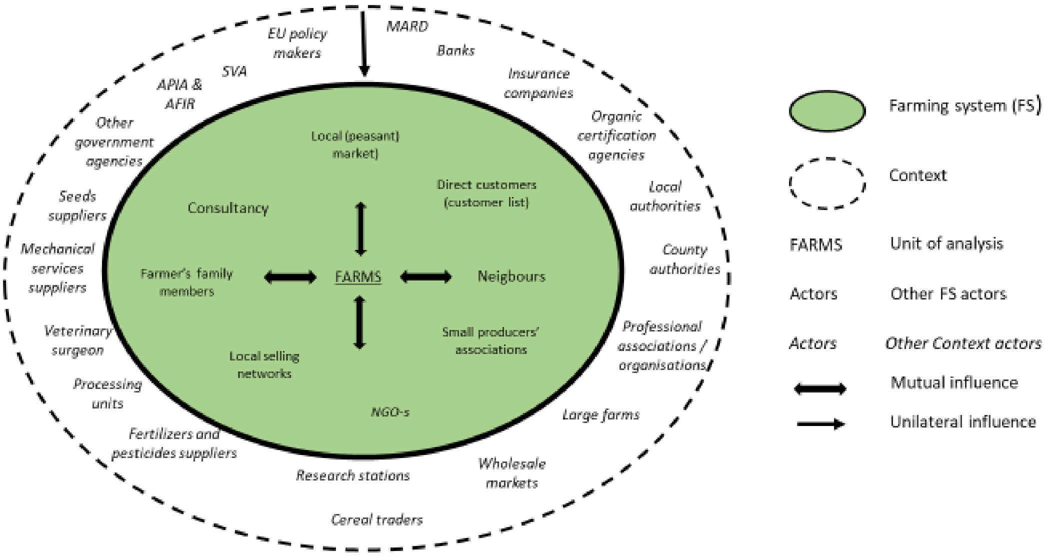


Figure 14.2. Farming system and context actors in the Romanian case study area (Nord Est region)[20].

14.3 CHALLENGES

14.3.1 Overview of identified challenges

Table 14.1 synthesizes the challenges identified across methods. A synthesis at farm and farming system level is provided in the next sections.

Table 14.1. Summary of challenges across methods.

			Environmental	Economic	Social	Institutional
Farmers	Ranking of challenges based on the farm survey	Small mixed farmers	1 (most relevant)	1 (most relevant)	4 (least relevant)	1 (most relevant)
	Shocks	Learning interviews	Extreme weather events (drought, floods)	Price volatility		Neo-nicotinoids ban
		Demographic interviews	Pests and diseases outbreaks	Input prices		Change of rules for EU projects implementation
			Increased frequency of droughts	Market uncertainty Fluctuation in yields	Personal events (illness, divorce, death)	Lack of cooperation

[20] MARD=Ministry of Agriculture and Rural Development; APIA=Agency for Payments and Interventions in Agriculture; AFIR=Agency for Funding Rural Investments; SVA=Sanitary-Veterinary Authority

			Environmental	Economic	Social	Institutional
	Long-term stresses	AgriPoliS focus group	Climate change	Land grabbing phenomenon Cash-flow	Lack of available labour	Difficulties in land sales procedures Lack of policy support for small farms
		Learning interviews	Pollution Poor soil quality	Low profitability Poor insertion in the supply chains Barriers to market entry	Farm split in the next generation Lack of sense of community	Bureaucracy
		Demographic interviews		Poor insertion in the supply chains	Succession problems Lack of available labour Lack of sense of community	
		AgriPoliS focus group		Low profitability of farming	Farm succession Lack of available labour	
Households	Shocks	Demographic interviews			Loss of an off-farm job of a family member	Change in local tax policy
	Long-term stresses	Demographic interviews			Succession problem	
Farming system	Shocks	ResAT	Extreme weather conditions	Price volatility		Change in CAP support
		AgriPoliS focus group		Higher costs with labour		
	Long-term stresses	ResAT	Climate change	Low profitability Very small size of farms excludes them from receiving direct payments Prevalent on-farm consumption (>50%)	Ageing farmers	Poor farm structure
		AgriPoliS focus group		Change in of the regional agricul-tural structure (re-orientation to field crops requiring less labour, at the expense of animal husband-dry which needs constant labour)	Competition for labour with other sectors Lack of skilled labor	No correlation between formal professional training and the labour market requirements
Farmin	t Shocks	FoPIA-SURE-Farm	Pests and diseases	Price fluctuations	Sudden changes of on-farm social capital	

		Environmental	Economic	Social	Institutional
Long-term stresses	FoPIA-SURE-Farm	Extreme weather (drought, flood, hail)	Emergence / loss of alternative off-farm income source	Succession problems	
		Climate change	Low farm-gate prices	Emigration of young people	
		Environmental regulations	Poor integration of small farms in agri-food chains	Lack of local labour	
			High costs of inputs and services	Lack of farming skills and knowledge	
			Low profitability of traditional agriculture	Farmers' ageing	
			Import competition	Experience acquired abroad as pressure for change	

14.3.2 Present challenges for farmers and farm households

In the farm survey, small mixed farmers scored environmental challenges the highest (4.81 on average), followed by institutional challenges (4.48 on average) and economic challenges (4.37 on average). Institutional challenges demonstrate no statistically significant difference to either economic or environmental challenges. Social challenges were scored the lowest (3.83 on average).

Several environmental challenges were identified in the two interview-based studies: climate change is perceived as the major environmental challenge in the long term, and more specifically drought as a shock. Other environmental issues were: pests and diseases – with focus on severe outbreaks such as Avian flu and the more recent Africa Swine Fever which affected severely the small farmers growing pigs in 2018.

Among the economic challenges, long-term stresses are linked to low profitability, barriers to market entry, fluctuations in yields and market uncertainty, while the most frequent shocks relate to products price volatility and increase of input prices.

Among institutional challenges, small farmers named as long-term stresses the lack of policy support for the small farms, aimed at their development and change into medium-sized farms, more commercially-oriented, idea supported also by the ResAT findings. As shocks, they named the ban on neonicotinoids, the frequent changes and unclear rules for EU funded projects implementation (from National Rural Development Program - NRDP), as well as frequent changes in the tax policy.

Social challenges identified in interviews are related to succession problems. First, if farmers in the region have several children (which is the most common case), the farm (especially the land) is split in the next generation, making even more difficult the efforts directed to land consolidation.

There is an overall lack of available local labor – a challenge mentioned in all interviews, as well as in the AgriPoliS focus group. Young people are not happy with relatively low farm incomes, and they move either to towns to find better paid out-of-farm employment, or they emigrate to work in Western countries agriculture. In many cases they do not quit completely the rural household and the agricultural activity: those who commute to towns are coming back and work part-time in the farms; those who emigrate are coming home for a couple of months almost every year to help their ageing parents working on the farm.

Focusing on labor issues, in the AgriPoliS focus group workshop, participants agreed that the availability of unskilled labor is an issue concerning primarily the small farms from NE region and availability of skilled labor force concerns, to a larger extent, the corporate/big farms from the region. Moreover, for the scarce skilled labor there is a competition between large farms, private inputs companies and government agencies involved in agriculture. The consequences of the labor shortage noted by the participants were: impossibility to carry out the agricultural works in time, additional costs, production losses that led to the change of the regional agricultural structure (re-orientation to field crops requiring less labor, at the expense of animal husbandry which needs constant labor). The solutions converged to a greater financial motivation and the creation of a legal framework to foster the integration of unskilled labor force on the agricultural labor market. Concerning the skilled labor force, the main challenge linked to its shortage resides in the fact that there is no correlation between formal professional training (from agricultural high-schools and universities) and the labor market requirements (such as high mechanization skills for modern equipment and managerial skills for running larger farms). During the discussion, it was pointed out that the agricultural vocational schools were disbanded, increasing the deficit on the agricultural labor market.

14.3.3 Present and past challenges for the farming system

The challenges identified are basically similar among the methods used (ResAT, interviews, FoPIA-SURE-Farm): environmental - climate change and extreme weather conditions, particularly droughts; economic: poor insertion in value chains, and a much-needed farm development through increasing productivity. A specific economic challenge resulted from the ResAT tool consists of the prevalence of on-farm consumption (>50% of the farm products) which does not allow for obtaining higher income by product sales. The social challenges are the farm owners' old age, coupled with a difficult transfer of farm to the new generation due to young people's migration to towns or to foreign countries. Institutional challenges are: a poor farm structure (very many small farms), and policy instruments not adapted to the needs of small farms.

Most of the challenges that the farming systems faced in the past remain relevant also as a basis for future resilience strategies.

14.4 OPPORTUNITIES

14.4.1 Present opportunities for the farming system

Current opportunities can be derived from the AgriPoliS focus group. Small land owners who have not the necessary equipment to farm the land can transfer their land operation on the basis of land lease contracts to larger commercial farms, which have the necessary resources to buy farm equipment and operate on larger scale. This is an opportunity also for land owners who live and work (in non-agricultural activities) far away from the farm (in general, urban inheritors of land, which did not wish to sell the land), and for old farmers which again do not wish to sell their farm.

Land operation consolidation increased in the region after the accession to the EU and the implementation of the CAP direct payment system. Land consolidation was positively perceived by most participants because: it enables the use of modern technologies in agriculture (including precision faming); it facilitates access on the market; it brings profit. Land consolidation for operation purposes is mainly characteristic for the plain areas of the case study region, while in the mountain areas the land consolidation process is much slower.

The immigrants from the Republic of Moldova participating in the seasonal farming activities in the NE region represent a solution to the crisis on the regional labor market. The advantages of hiring immigrants include stability of workers throughout the seasonal activity for which they were hired, because immigrants receive accommodation on the farm where they are hired and thus there is a low risk for these workers to leave for another farm, as it happens with the local people.

14.4.2 Past opportunities for the farming system

After of the fall of the communist regime, a large part of the rural population lost their jobs in the former state-owned industry. The agrarian reform that followed led to the creation of small and very small farms whose owners did not have operating capital or the necessary cash to invest in modern equipment. The effect was the emergence of a type of agriculture where the subsistence and semi-subsistence farms prevailed, with rudimentary farming practices. Besides the poor performance of the small farms, the lack of non-agricultural occupational opportunities generated a high dependence on agriculture of rural households and rural poverty increase. On the other hand, immediately after the fall of communism the small farms became the back-up solution to ensure the survival of rural households in the context of the general restructuring of the economy.

Although opportunities were not the key topic in FoPIA-SURE-Farm workshop, it was possible to outline some ideas resulting from the discussions. First opportunity of the recent past was (as discusses also above) the Land Law of 1991, which restored private ownership of land after the communist era. This marked the start of transition to market economy, encompassing land, animal and equipment ownership. It was followed by privatization and reorganization of processing units, rapid development of private retail and of export/import enterprises. Market relations and institutions were introduced gradually during the transition period (1990-2000).

The greatest opportunity in the sector came along with the country' accession to the EU, and the integration of common agricultural policies, which came with important financial support for investments, modernization and development of farms and other economic operators involved in the agri-food products supply chains.

14.5 FUNCTIONS

14.5.1 Farmers and farm households

The farm survey showed that in the Romanian case study (small mixed farms) 'delivering high quality food products' and 'animal welfare' are the two most important functions, followed by 'ensuring a sufficient farm income', and 'maintaining natural resources (e.g. water, air, soil) in good condition' (Figure 14.3).

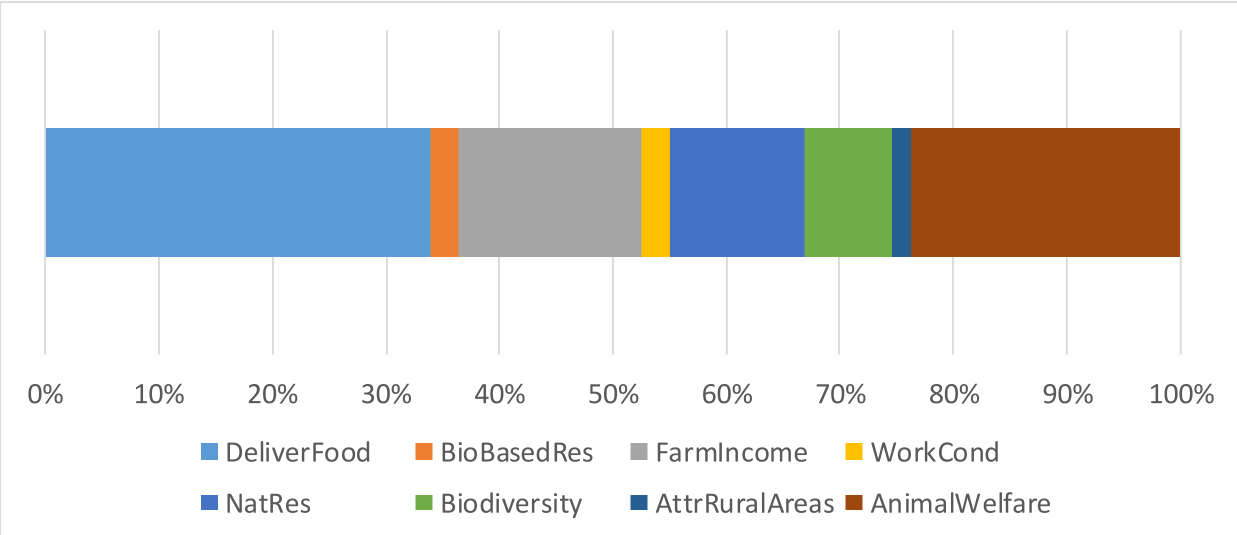


Figure 14.3. Essential functions (averages) according to the farm survey

Note: FarmIncome – ensure a sufficient farm income; FoodSupply – deliver high quality food products; NatResources – maintain natural resources (e.g. water, air, soil) in good condition; AnimalWelfare – ensure animal welfare; WorkConditions – provide employment and good working conditions for employees; BiodiversityProtect – protect biodiversity; AttractiveCountryside – ensure the attractiveness of rural areas in terms of agro-tourism and residence; BioEnergySupply – deliver bio-based resources (e.g. hemp, wood) to produce biomass and biofuels

Similar results were obtained in learning interviews, where most farmers indicated the delivery of 'high-quality food products' and 'animal welfare' as the most important functions, followed closely by 'income and profitability'. Some farmers indicated also the 'attractiveness of rural areas', since they were involved in agro-tourism activities. The demographic interviews showed that 'animal welfare' and 'biodiversity' are seen as important public goods, but not the 'natural resources'. This may be linked to the fact that small mixed farms are generally extensive, and there is little concern for overuse / unsustainable of natural resources.

14.5.2 Farming system

The FoPIA-SURE-Farm workshop revealed detailed insights regarding essential functions for the farming system. 'Food production' is the most important function for farmers and processing units; while economic viability seems to be most important for government; attractiveness of the area most important for NGO-s, since their activity is oriented to the sustainable development of the rural area in the region, based on stimulating the farms to diversify their activities and income sources (through local/on-farm processing, selling the farm products on local markets, etc.) (Figure 14.4).

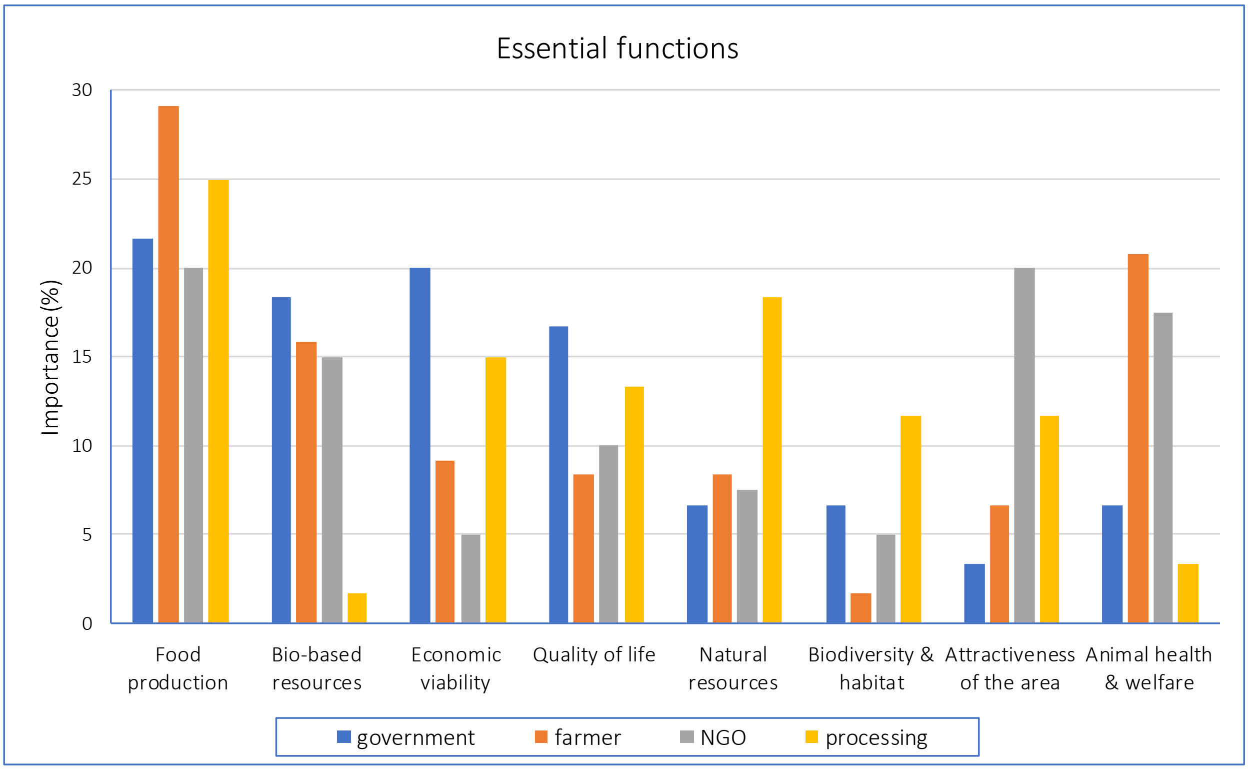


Figure 14.4. Bar graph with scoring per function, aggregated by stakeholder group (100 points divided over 8 functions) (n=14) ("processing" refers to stakeholders from processing units) (Source: Gavrilescu and Tudor (2019))

When analyzing the performance of functions by different stakeholders, the picture changes somehow: 'food production' (private), 'animal health & welfare' (public) and 'natural resources' (private) scored highest; farmers and government value much more the private functions, while processors and NGO-s score private and public goods in a quite similar way.

Most important indicators (aggregated by all stakeholders) score moderate to good (between 3 and 4) (reflected by the size of the bubbles on Figure 14.5). 'Economic viability' was perceived as being the best performing function (3.84 in terms of average scores), followed closely by 'animal welfare' (3.65), 'food production' (3.58) and 'attractiveness of the area' (3.64) (Figure 14.5).

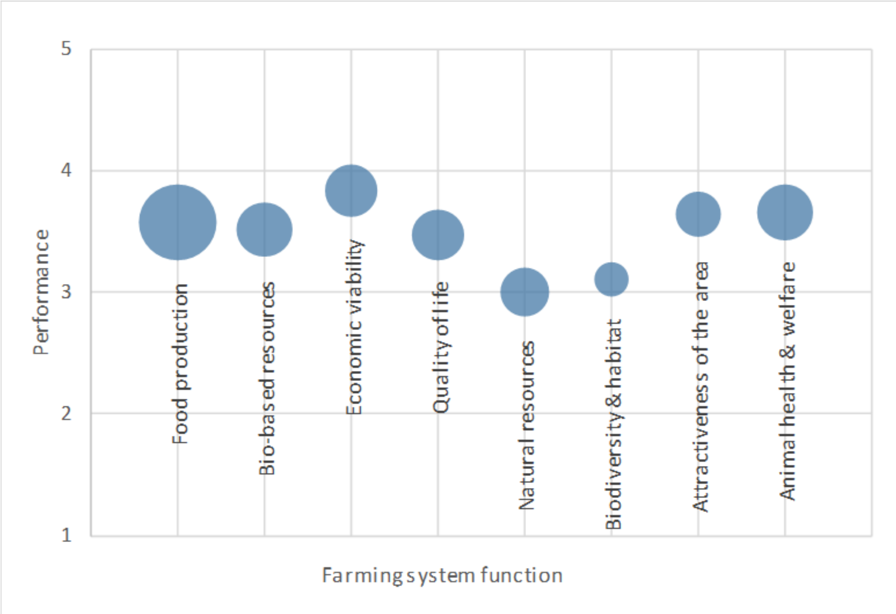


Figure 14.5. Bubble graph presenting averaged scores on performance of functions (from 1=poor performance to 5= excellent performance), while also indicating their importance (size of the bubbles), relative to each other (n=14) (Source: Gavrilescu and Tudor, (2019))

The first two functions are to be expected to be seen as essential, since the farming system is about mixed farms (various crops and livestock). Similar to interviews, participants of the FoPIA-SURE-Farm workshop scored current performance of public goods functions moderate to good, with exception of 'biodiversity & habitat' (moderate) and 'natural resources' as the lowest one (3.01).

Figure 14.6 shows the average total importance and performance of the indicators: most of them performed rather well (means between 3.0 and 4.0). By far, indicator 'subsidies' performed the best, all stakeholders acknowledged its importance in the analyzed farming system, given that in small farms, subsidies may cover up to 30% of the production costs. Only few indicators (3 out of 24) scored moderately on the total (means between 2.7 and 2.9): 'awareness of biodiversity importance', 'quantity of fertilizers used' and 'management of agricultural waste'. Overall, no relatively important indicator performs bad; yet, important indicators such as 'sales of crop and vegetable products' and 'transport infrastructure' show moderate performance. The poor insertion of small farms in the agricultural supply chains is reflected in the moderate performance of the 'sales' indicator, and this challenge has been identified also in demographic and learning interviews. The 'transport infrastructure' indicator was seen by the FoPIA-SURE-Farm stakeholders as being in connection with the indicator 'sales of crop and vegetable products', since the poor condition of many local roads is a problem for small farms located in remote areas in terms of access to urban markets.

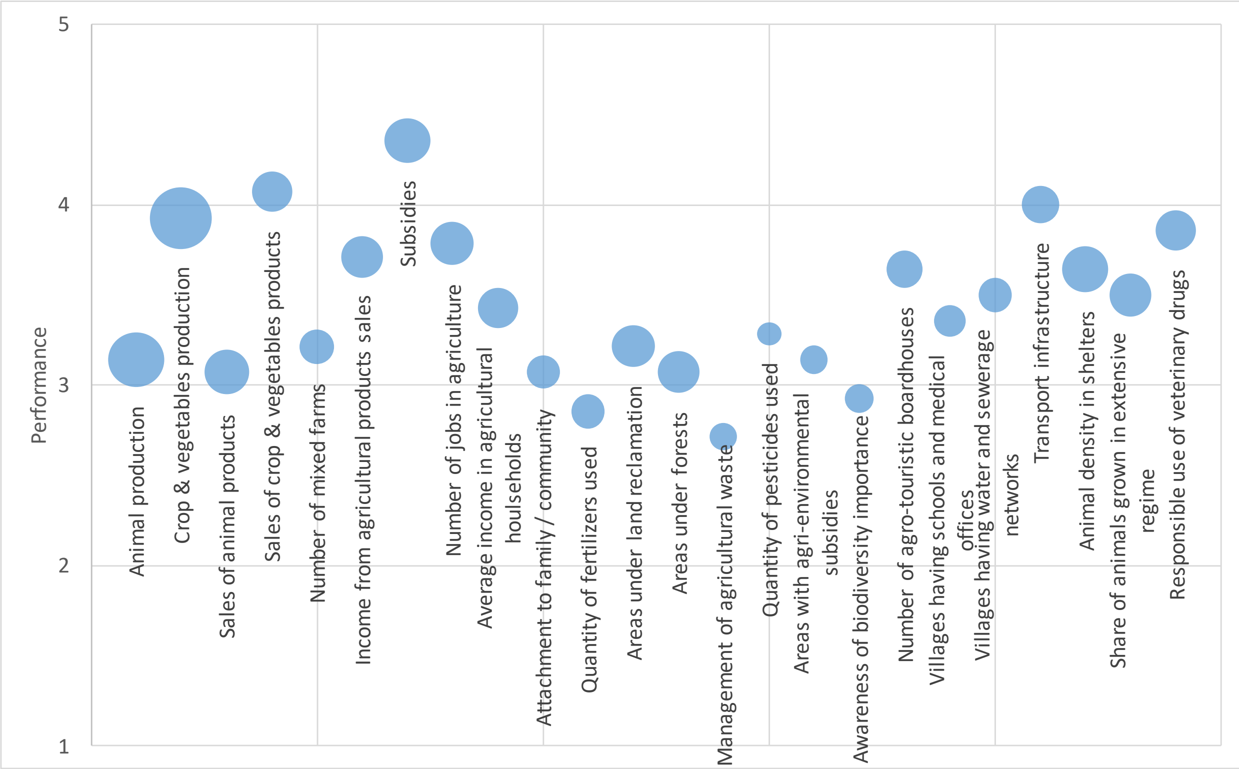


Figure 14.6. Bubble graph presenting averaged scores on performance of indicators (from 1=poor performance to 5=excellent performance), while also indicating their importance (size of the bubbles), relative to each other (n=14) (Source: Gavrilescu and Tudor, (2019))

The ecosystem services (ES) assessment shows that the current performance of 'food crop production' and 'fodder crop production' score low (~0.15, respectively ~0.1, on a scale from 0 to 1), while 'grazing livestock density' and 'timber removal' score even lower (close to 0). Only energy production scores moderately (~0.35) compared to other EU regions (Figure 14.7). Crop and fodder production, as well as animal husbandry are extensive activities in the case study region.

Regarding public goods (Figure 14.8), 'capacity to avoid soil erosion' (~0.8) and 'water retention index'(~0.6) perform good, while 'habitat quality based on common birds' and 'recreation' have a moderate performance (~0.25, ~0.2 respectively). All the other services have a poor performance (close to 0) (ranked in decreasing order: 'carbon storage', 'NOx retention capacity', 'organic matter in topsoil concentration', and 'pollination potential'.

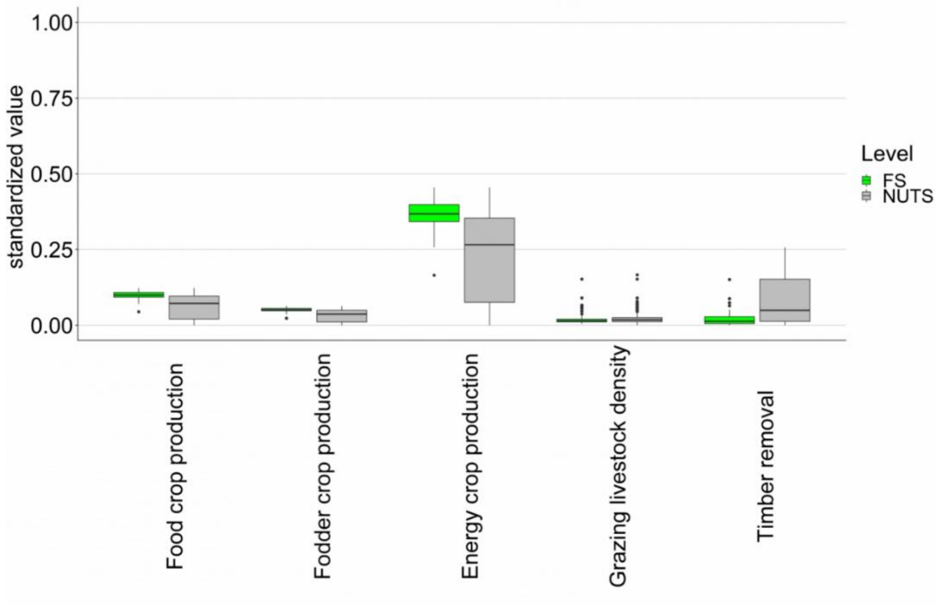


Figure 14.7. Current performance of ecosystem services related to private goods according to the ES assessment.

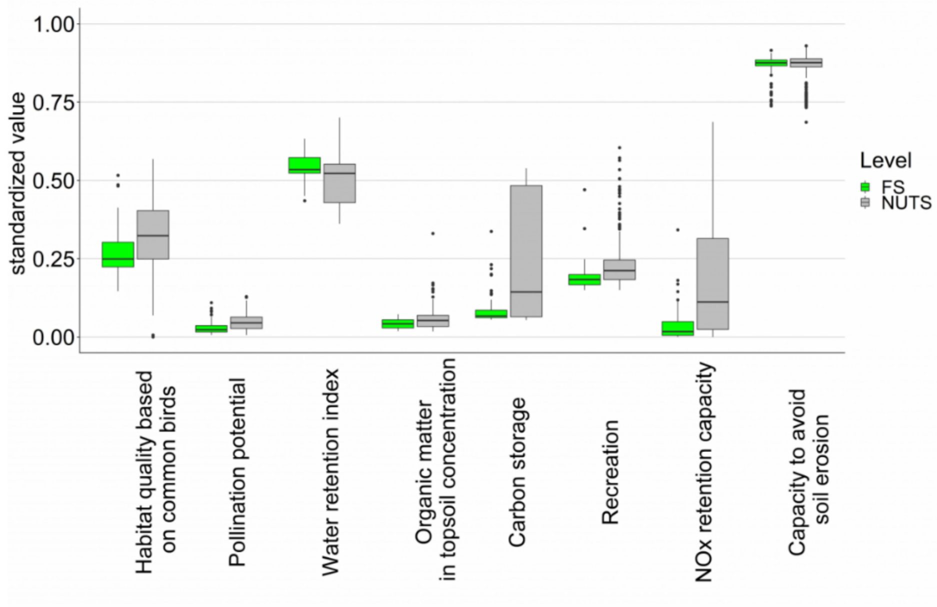


Figure 14.8. Current performance of ecosystem services related to public goods according to the ES assessment.

14.6 RESILIENCE CAPACITIES

14.6.1 Farmers and farm households

At farm level, transformability scored highest on average (4.3), followed by score for adaptability (4.2), without being statistically different. For small mixed farmers, robustness scored lowest (3.6). Examples of transformability revealed in the learning interviews include flexibility in terms of adjusting agricultural practices, farm size, production structure; investing in technologies to control environmental risks (irrigations, use of protection chemicals); investing in technologies to increase farm efficiency (such as innovative equipment); looking for new markets for new products; learning to use new technologies and active seeking for information. These findings are in line with literature (Matei, 2013). Readiness to change typical and traditional activity patterns and technologies as an example of transformability was confirmed during the demographic interviews. Furthermore, mostly young successors that have lived and worked abroad were found to be the main driving forces of transformability, since they returned home with acquired models of modern farms productivity and efficiency. This approach might have a hindering impact on farm succession, since old farmers are not willing to change their traditional way of farming.

Adaptability was usually triggered by changes in and decrease of prices, poor soil quality, and farm fragmentation, as revealed in the learning interviews. Consequently, farmers increased the size of farm by buying or renting land, introduced mixed farm activities (crops and animals), diversified through processing the farm products, or started the process of organic certification. The demographic interviews confirmed these examples of adaptability. Some young farm successors initiated “new activity direction”, or joined a cooperative member and adapted farming accordingly.

Robustness is generally considered to be a natural feature of small mixed farms, due to their lack or low connection with external markets, and due to their diversity in farm activities. In the learning interviews, such robust farms were generally very small, with high on-farm consumption or very old farmers with no successors. Indeed, farmers expressed in the learning interviews that their financial performance was stable, despite the summer drought of 2018. Production smoothening resulted in robust production. In terms of farm succession, robustness was often revealed on farms with a relatively old “head of the family”, claiming that the succession will take place only after his physical *disappearance (“… after I’m gone, my children will do what they want, but until then, they do as I say”)*.

14.6.2 Farming system

According to the stakeholders in FoPIA-SURE-Farm workshop, subsidies and production are the core elements having a strong positive relationship with robustness, adaptability and transformability in the farming system. Both strategies (‘information actions’ and ‘ensuring the correctness of paperwork’) regarding the subsidies are seen as having positive effects on all three forms of resilience (Figure 14.9). Land consolidation appears to be essential for resilience capacities – the average size of farms in Nord Est region is 2.65 ha), which is very small in the European context (Romanian Farm Structure Survey, 2016). Introducing more technology is also essential for any agricultural development effort in the case-study area. Increasing farm size in combination with new technologies is assessed to positively contribute to all three resilience capacities. In the discussions on the historical dynamics of indicators ‘sales of crop, vegetable and fruit products to processors’ and ‘crop, vegetables and fruit production’, it was mentioned that in 2007, when Romania joined the EU, intense and sudden emigration led to a deficit in labor force and resulted in the need for land consolidation and investment in agricultural machinery.

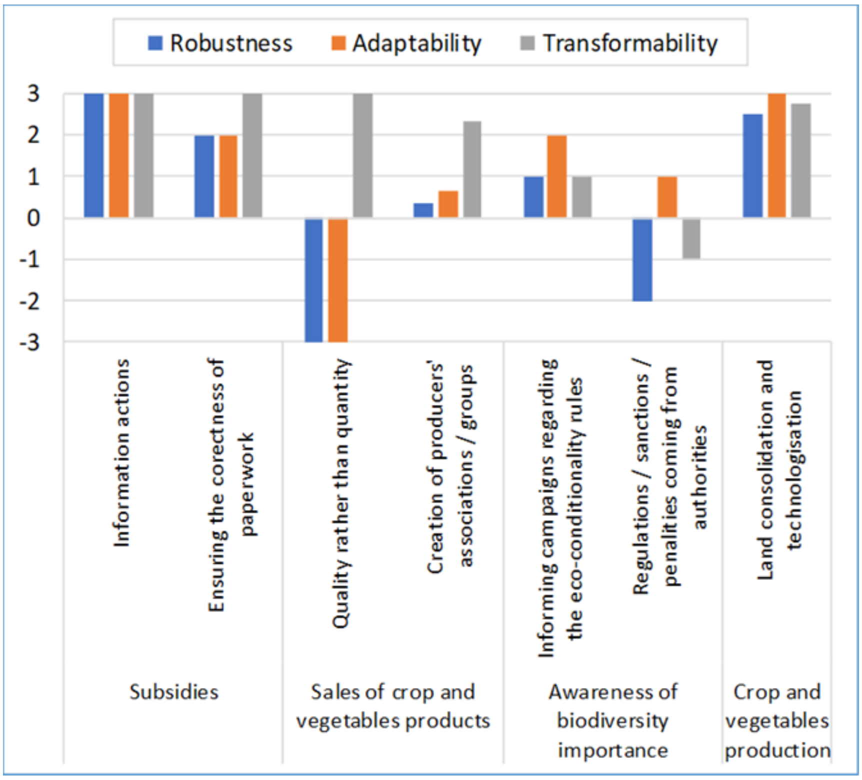


Figure 14.9. Strategies applied to cope with challenges affecting the indicators 'subsidies', 'sales of crop and vegetables products', awareness of biodiversity importance' and 'crop and vegetables production', and their perceived contribution to the three resilience capacities according to stakeholders participating in the FoPIA-SURE-Farm workshop [participants had to score between -3 ("heavily constraining resilience of the FS") and +3 ("heavily enhancing resilience of the FS")]. (Source: Gavrilescu and Tudor (2019))

Sales of quality products is perceived as a strategy having a negative effect on robustness and adaptability, as it diminishes the current turnover. Since consumption of 'regular' products is mainly driven by low price and not quality of products due to the consumers' modest purchasing power, high quality products are still seen as 'niche products'. . Yet, the strategy is assessed to have a positive effect on transformability, as only complete re-orientation of the farm to niche products or vertical integration of farm activities (from production to processing and sales) can allow to exploit the price difference between 'regular' and 'high quality' products. Consequently, for this strategy a trade-off was perceived between robustness and adaptability on the one hand and transformability on the other hand.

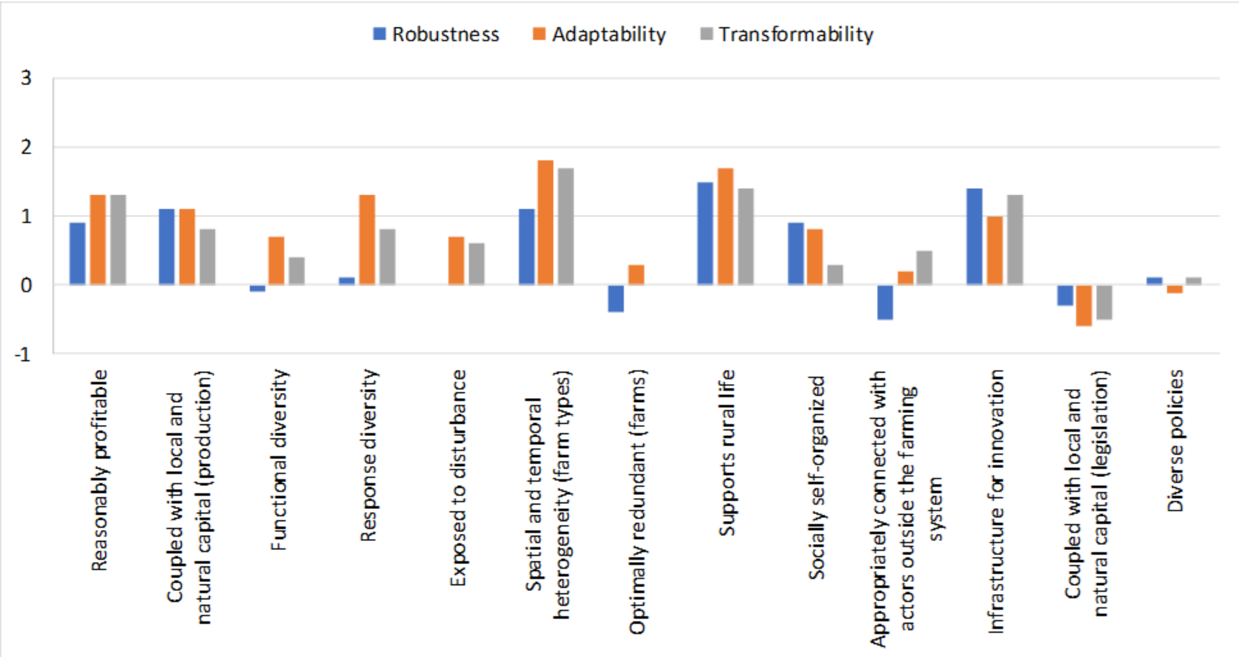


Figure 14.10. The contribution of 13 selected resilience attributes to 3 resilience capacities, according to the stakeholders in FoPIA-SURE-Farm workshop [participants had to score between -3 to + 3, indicating negative (-) or positive weak, medium or strong relationship (resp. 1, 2 and 3), 0 indicates no relationship] (Source: Gavrilescu and Tudor (2019))

As for attributes selected for the FoPIA-SURE-Farm workshop, most are perceived to have a positive effect on robustness (10 of 13), adaptability (11 of 13) and on transformability (12 of 13). 'Spatial & temporal heterogeneity' and 'supports rural life' were the only attributes perceived as having a relative moderate (between 1 and 2) effect on all three resilience capacities (simultaneously). 'Coupled with local & natural capital (legislation)' is seen to have a weak but negative effect on robustness, adaptability and transformability, indicating that the stakeholders in the farming system are largely unsatisfied with the current legislation and regulations. This is in line with the results from ResAT analysis, which showed that the policy constellation is enhancing the robustness of the farming system to a limited extent. Direct payments provide essential working capital with additional payments for smaller holdings, complemented by inter alia free water supply. Support for risk management appears to have a limited effect (Figure 14.11).

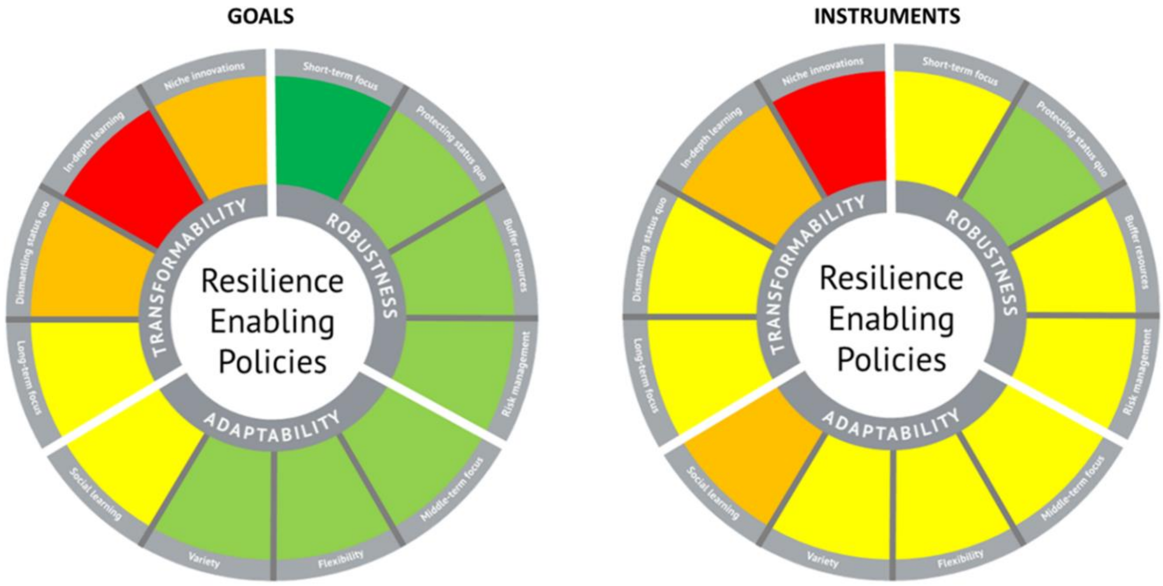


Figure 14.11. The ResAT wheel applied for the arable farming system in the Nord-Est region of Romania. The attributes are the key characteristics for resilience-enhancing policies. The given colors indicate to what extent the key characteristic is enhancing or constraining the resilience capacity (Red = Not enhancing or very constraining; Orange = Slightly enhancing or constraining; Yellow = Fairly enabling or fairly constraining; Light green = Enhancing or slightly constraining; Dark Green = Very enhancing or not constraining). (Source: Voicilaș and Luca (2018))

Various measures to enhance adaptability are available but access is obviously difficult for small farms. There are various attempts to enhance transformability as well. The main aim appears to be structural consolidation. The overall effect on the resilience of small farms appears to be limited, and the agricultural policy has competing aims: support for small famers as part of rural social policy versus structural transformation towards larger, more competitive holdings. Yet, subsidies for small farms are not sufficient to induce business development; while support for the transition from peasant farming to more specialized business models and commercialization is seen as desirable, but market access remains at issue.

14.6.3 Concluding remarks on resilience capacities

The farming system seems more transformable than adaptable and robust, although the main strategies implemented in the past contributed to all capacities. Subsidies and land consolidation contributed to all three capacities. Sales of quality products and sanctions related to biodiversity regulations contribute negatively to robustness and adaptability.

On the other hand, the policy constellation contributes mostly to robustness, much less to adaptability and is almost non-effective (but not constraining) on transformability. For the mixed farms from the Nord Est Region, there is a discrepancy between policies and the instruments for their implementation (better policies than instruments), due to the inherent difficulties in transposition under the form of efficient and fair programs of relatively generous measures defined as policy objectives. This is true in terms of robustness and adaptability. For transformability, both policies and implementation instruments are poorly adapted.

14.7 RESILIENCE ATTRIBUTES

14.7.1 Farmers and farm households

Small size mixed farmers are part of networks that favor learning. Learning interviews showed that farmers are involved in learning strategies and processes that farmers used in order to keep-up and / or adjust their knowledge and be better equipped for facing the risks and challenges, such as experimenting, learning from others, seeking out information, reflexivity. Learning new skills by going on training courses, learning how to use new technologies and learning about alternative ways of farming provide necessary knowledge for experimentation of novelty at farm level and gives confidence to adapt farming activities. The adaptation rhythm depends on farmers' attitude towards risk and their experience. Seeking out information allows farmers to catch up new idea on internet or other sources (books, newspaper) and is an important ability for learning how to adapt. Being open to new ideas related to farming aims to offering farmers comparative and competitive advantages. Learning from others refers to the farmers' involvement in supportive social networks that foster learning and through that, increase their ability to cope with risks and challenges.

As revealed by both demographic and learning interviews, the households seem to perform well in diversity, in the sense that some agricultural households rely upon other activities such as on-farm transformation (small-size processing) and agri-tourism. The survey revealed that many farmers consider such diversification as a strategy for dealing with the challenges on their farms.

The sense of community is quite low among farmers, as shown by both learning and demography interviews. The same is valid for the farmers' willingness to associate or become a member of a cooperative – bad memories of old communist cooperatives are still there after three decades since their dismantling. The younger farmers' reluctance for cooperation is also a consequence of the failure of many new cooperatives (set up after the communist times), mostly due to bad management.

14.7.2 Farming system

According to stakeholders, resilience attributes in the Nord-Est region scored moderate to high. (2.66 for the overall performance, with most attributes being scored between 2 and 3). The best performing attributes were "Production coupled with local and natural capital" (3.6) and "Spatial and temporal heterogeneity" (3.6), followed by "Infrastructure for innovation" (3.3).

More specifically, diversity in the farming system is moderate to high, given the scores for "Functional diversity" (2.1) and "Response diversity" (3.0). Modularity scores higher than diversity, looking at "Spatial and temporal heterogeneity of farms" (3.6). The system reserves seem to be moderate with regard to "Reasonably profitable" (2.3) and high with regard to "Production coupled with local and natural capital" (3.6) and "Support rural life" (3.1) (Figure 14.12).

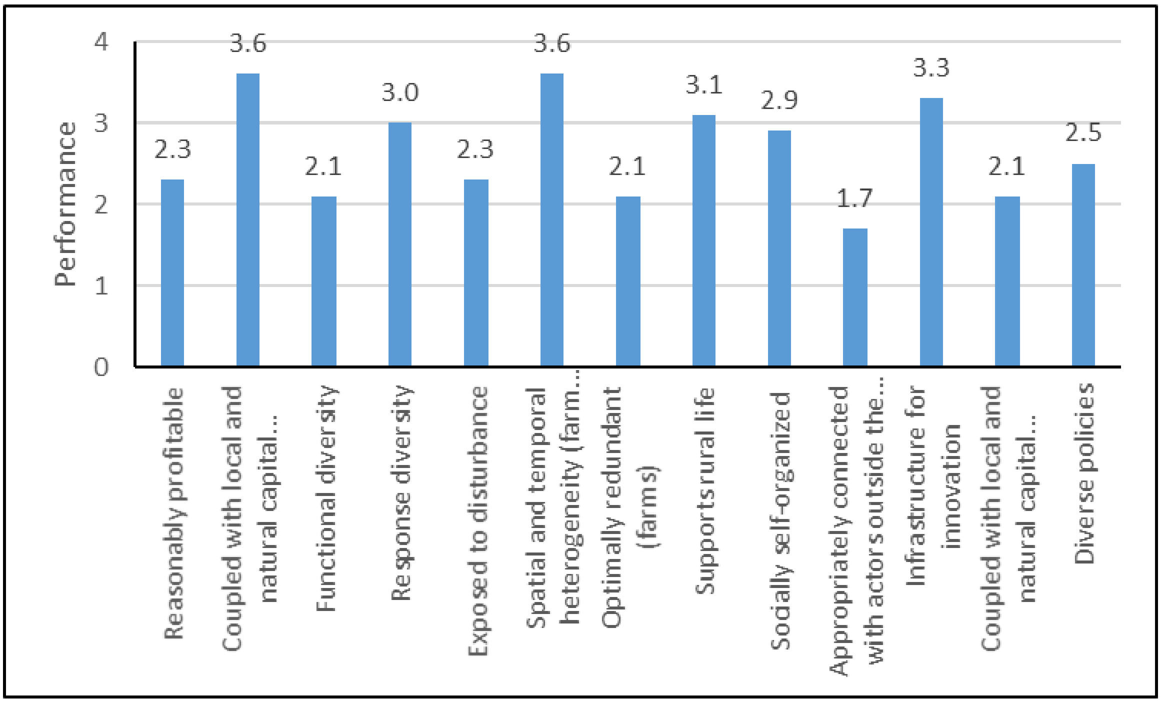


Figure 14.12. Performance of attributes on a scale from 1 (not at all performant) to 5 (very big extent of performance) (Source: Gavrilescu and Tudor, (2019))

Farm demographics in the region are reflected by "Spatial and temporal heterogeneity of farm types" (3.6), and "Supports rural life" (3.1) and scores high. Tightness of feedbacks of the system is considered low, looking respectively at "Appropriately connected" (1.7), "Coupled with local and natural capital (legislation)" (2.1), and "diverse policies" (2.5). The first two mentioned attributes score the lowest, showing an inefficient way the system is governed. Openness of the system is considered to be moderate to high, looking at the attributes "Exposed to disturbance" (2.3) and "Infrastructure for innovation" (3.3).

As for constraining attributes, only "Coupled with local and natural capital (legislation)" is perceived so for all three resilience capacities; "Connected with actors outside the farm", "Redundancy", and "Functional diversity" are slightly constraining for robustness; "Diverse policies" for adaptability, the rest are not constraining.

14.7.3 Concluding remarks on attributes

Across methods, for all resilience principles, resilience enhancing and constraining attributes were identified (Table 14.2).

Table 14.2. Summary of findings on attributes across methods. Related processes are in brackets (FD: farm demographics, AP: agricultural practices, RM: risk management, and G: governance).

	Farming system		Farmer, Farm household	
	Enhancing	Constraining	Enhancing	Constraining
Diversity	Heterogeneity of farm types (FD, RM)	Low functional diversity (RM) Low response diversity (RM)	Multifunctional farming (AP, RM)	Resistance to change (RM)
Openness	High level of infrastructure for innovation (RM)	Lack of policy instruments dismantling status quo (G)	Open-minded successor (FD)	Reluctance to cooperation (FD) Old traditionalist farmer (FD)
Tightness of feedbacks	Moderate level of self-organization (RM)	Poor connection with actors outside the FS (RM, G) Poor connection with legislation and regulations (RM, G)	Engaged in networks, exploring collaboration (G, RM)	
System reserves	Reasonable profitability (AP) Well coupled with production local and natural capital (RM, FD)	Poor instruments for risk management (G)	Alternative forms of farm succession (FD)	
Modularity	Heterogeneity of farm types (FD, RM)	Few policy instruments for change and development (G)	Reflexivity, experimenting (AP, RM)	

14.8 ADAPTIVE CYCLE

The farming system seems to be on the way between reorganization and growth phase. The farming system of small mixed farms emerged only 30 years ago, at the moment of dismantling of former communist cooperatives and transition to the market economy. The system is reorganizing in the sense that land consolidation and CAP funding contribute to the increase in size of the farms, by allowing to trade land and invest in farms. This contributes to the reduction of the number of small farms and increase of their size. Growing refers to improvement, to enhancing the farms' capacity to develop and insert in the value chains, and increasing farm incomes.

With regard to the separate processes, they are in various phases (Figure 14.13). *Agricultural production* is on an upward growing phase, investments and new technologies contribute to increased productivity.

Farm demographics is half way between conservation and collapse; there is still a generation of old farmers that value land as their most dear asset (irrespectively of its profitability) and only their disappearance in time will make room for successors that are willing to develop their farm and consider land as an economic asset, not a spiritual one to be kept at any costs. Farm demographics goes towards collapse mostly because of a significant migration of people from rural to urban areas and to other countries. There is already a succession problem in many farms run by old farmers; their children left and do not intend to return and take over the farm, since they already made a living for themselves and their families out of the rural areas or even out of the country. And (as some demography interviews revealed), some farmers that are currently in activity (aged 35-50 years) are encouraging their children to choose non-agricultural professions, so the young generation to be able to have higher incomes from other economic activities and enjoy a higher quality of life in urban areas.

Governance is close to conservation. The current agricultural and rural development policies are poorly targeted to small mixed farms; they are rather oriented to the development of medium-size farms, commercially-oriented. Nevertheless, some policies targeted specifically to small farms are in place, but not enough to enabling a significant development.

Risk management is on its way to reorganization: for the moment there are no viable instruments for risk management dedicated and adapted to the needs of small farmers.

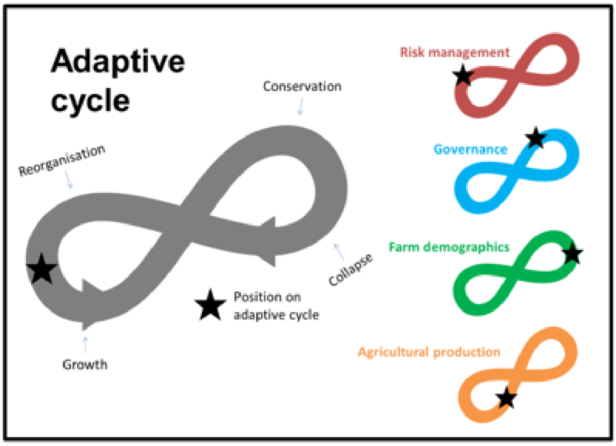


Figure 14.13. Positioning the Romanian small mixed farming system on the adaptive cycle of processes in agriculture

14.9 STRATEGIES

The overall target of the Romanian agricultural policies is to support in medium and long term the development of medium-sized, commercially oriented family farms. Since maintaining the current status quo (large number of small farms) is not likely to enable development, strategies for the future should focus on adaptability and transformability, in order to foster the emergence and development of more viable and profitable farms. Table 14.3 summarizes future strategies mentioned per process.

Table 14.3. Future strategies per process.

Processes	Future strategies
Agricultural production	- New technologies, new machinery and equipment adapted to the needs of small farms - New crops / varieties to improve diversity. - Diversification of activities; farm products processing - Organic production.
Farm demographics	- Succession could be stimulated by offering old retiring farmers decent pensions or life annuities, and to young farmers easier access to finance and adapted financial instruments for funding operating capital and investment capital - For unskilled labour: continuous adult training and programs for exiting agriculture - For skilled labour: better adaptation of school / university training to the demand in the agricultural sector
Governance	- More stable policies and fiscal regulations - Improved consultancy system - Facilities and incentives for cooperation - Funding / credit instruments adapted to small farms to enable their development and enlargement to medium-sized farms
Risk management	- Technological and managerial improvement to cope with climate changes - Insurance instruments adapted to small farms - Diversification of activities

14.10 CONCLUSION

The Romanian case study is devoted to small mixed farms in the Nord-Est region. The farming system, consisting of a large number of farms (more than half a million), of small size (as compared to European farms),and of poor efficiency and profitability, faces many challenges, such as reluctance to association and cooperation (due to bad memories from the communist past), poor insertion in the agricultural products supply chains. Pressure of more competitive imports, price volatility from the domestic and international markets and migration of labour are completing the picture. The adaptive cycle shows a complicated dynamic within the farming system itself: agricultural production is on an upward growing phase; farm demographics is half way between conservation and collapse; governance is close to conservation, and risk management is on its way to reorganization. Overall, the agricultural system seems to be on the path from reorganization to growth. The system responds using its resilience capacities. Transformability is currently the most favored by the stakeholders involved in this study, but due to its size and diversity, the studied farming system responds also through adaptability, and less through robustness.

15 CURRENT ECOSYSTEM SERVICE PROVISION: A CROSS CASE-STUDY COMPARISON

Corentin Pinsard, Francesco Accatino

15.1 ABSTRACT

Provision of multiple private and public goods is recognized as a factor that enhances the resilience of a farming system. In this chapter we investigate the ability of the SURE-Farm case study farming systems to provide multiple ecosystem services, which can be considered as public and private goods provided by the biophysical system. We used publicly available datasets of indices of ecosystem services covering all over Europe. We cropped the parts of the maps related to the NUTS3 regions containing the SURE-Farm case study systems and the farming systems itself. In this way, we could compare (i) the ecosystem services provided by the NUTS3 regions with the European average and (ii) the ecosystem services provided by the farming systems with the ecosystem services provided by the NUTS3 regions containing them. In this way we could investigate on (i) the main functions provided by the NUTS3 regions containing the case study farming systems and (ii) on whether the farming systems are increasing or decreasing multifunctionality to their region. Results from data were submitted to the judgment of case study expert that could either agree or disagree with the results presented, providing explanations. Indeed, experts suggested some modifications due to the fact that the indices of ecosystem services could not account for specific practices or aspects of the ecosystem services (e.g., wind erosion or aspects of recreation potential not strictly linked to the degree of land cover naturalness). The final results, accounting for the indices and the expert corrections, classified the SURE-Farm case studies belonging to one of two groups: (i) farming systems bringing multi-functionality to the surrounding regions, or (ii) farming systems removing public goods to the region to focus on the delivery of private goods. In group (i), the British case study improves the multi-functionality of the region via application of practices for improving carbon storage, erosion control and recreation potential; the Italian farming system brings functions intrinsically connected to the presence of permanent crops (e.g., habitat quality, recreation potential); the French and the Spanish case study bring functions complementary to the rest of the region. In group (ii), the Bulgarian case study is formed by monocultures poor in habitat quality and organic matter in soil; the Romanian farming system decreases almost all the public goods of the region (especially carbon storage, NO_x deposition, and habitat quality); the Dutch and the Polish case study remove public goods to a region already poorly multifunctional; the German case study lowers the level of multi-functionality in a region moderately multifunctional; and the Swedish farming system is clearly disconnected from the surrounding region which is mostly occupied by forests.

15.2 INTRODUCTION

Farming systems depend on and provide ecosystem services (Power, 2010; Zhang et al., 2007)(Figure 15.1). In particular, regulating and maintenance services (e.g., organic matter in topsoil concentration and pollination) constitute the basis of some processes that favor agricultural production. In turn, farming systems provide ecosystem services that can be considered as private goods (e.g., food and resource production) and public goods (e.g., habitat quality and carbon storage) (Dale and Polasky, 2007). Indeed, the ecosystem services provided by farming systems can positively influence the regulating ecosystem services, sustaining feedback loops that promote a healthy and resilient farming system. For example, habitat quality can be promoted by the farming system and, in turn it can be important for improving pollination potential that is beneficial for crop cultivation.

An interruption of such a virtuous feedback loop can cause a loss of resilience in the farming system. For example, high inputs of synthetic fertilizers and pesticides are detrimental to some ecosystem services (e.g., habitat quality and organic matter in topsoil concentration). In this way, the system would be much dependent on artificial input and loses the capacity of self-regulation. Cabell and Oelofse (2012) argue that, a system which is "coupled to the natural capital" is more likely to be resilient. The framework developed in SURE-Farm (Meuwissen et al., 2019) highlights the importance of resilient farming systems to provide multiple public and private goods. Therefore in this chapter we investigate on the capacity of the SURE-Farm case studies to provide multiple ecosystem services.

Indeed, there is a strong similarity between the notion of "private and public goods" used in the SURE-Farm project and the notion of "ecosystem service". Ecosystem services have been defined as the goods and benefits provided by natural processes and components (de Groot et al., 2002). Farming systems have the potential to promote the provision of ecosystem services by enhancing certain practices (Dumont et al., 2018; Power, 2010). For example, grasslands in extensive grazing can promote carbon sequestration (Accatino et al., 2019), the use of flower strips can promote pollination (Blaauw and Isaacs, 2014), and certain agricultural landscapes can provide habitat for some bird species (Teillard et al., 2017).

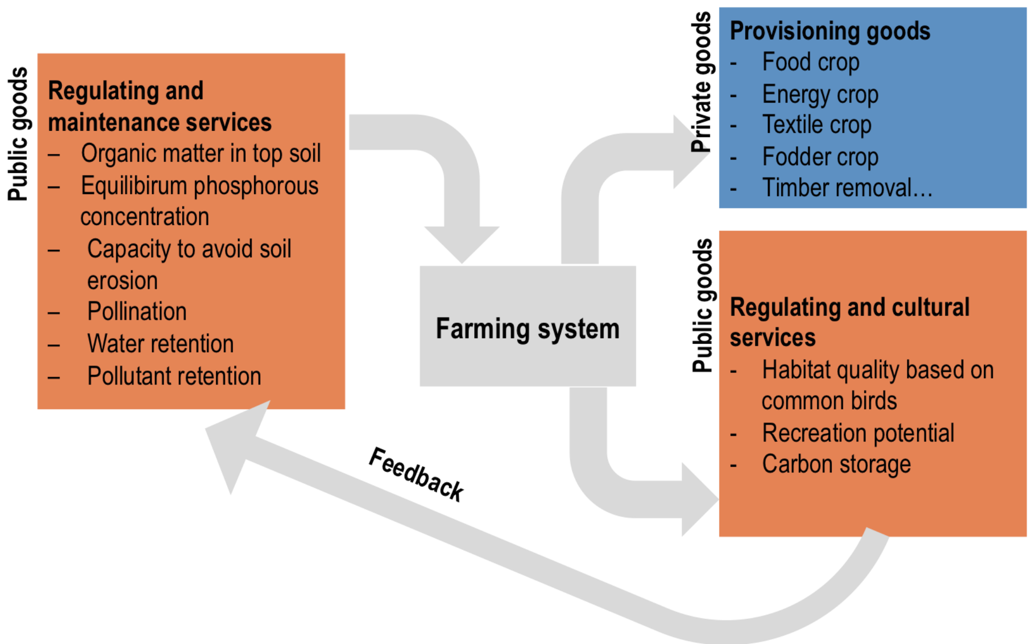


Figure 15.1. Scheme of interactions between ecosystem services and the farming system (adapted from Zhang et al. (2007)). Farming system depend on the provision of ecosystem services and, in turn, provide other ecosystem services.

It is important to notice that ecosystem services are only a part of the functions that can be promoted by farming systems. The "ecosystem service modelling" in the context of the SURE-Farm project refers only to the bio-physical level. For example, animal welfare or economic viability cannot be captured. Hence, the complementarity with other methodologies used in WP5 for a more complete assessment of the resilience of farming systems.

Another important thing to consider is that in this report we consider ecosystem services related to agricultural production as "private goods" (just because they can be put on the trade) and other ecosystem services as "public goods" (such as pollination, habitat quality and erosion control, that cannot be traded).

15.3 RATIONALE

We used publicly available datasets to compute the amount of public and private goods provided by 11 farming systems under study within the SURE-Farm project. Data consist in layers provided by the Joint Research Center (Maes et al., 2015) which map the indices describing 13 different ecosystem services in Europe. From these layers, we extracted the spatial information relative to the 11 SURE-Farm case studies as well as to the NUTS3 regions containing them and computed the distribution, average and variability of the private and public goods.

The aim was to assess the performance of different ecosystem services in the NUTS3 regions containing the case studies as well as in the specific cells containing the farming systems. In this way, we could perform two levels of analysis

- Comparison of the ecosystem service delivery in the NUTS3 region and Europe. This comparison serves to investigate the main context into which the farming system is located. It gives the idea of the main functions that can be enhanced by the farming system or, on the contrary, are threatened by its expansion.
- Comparison of the ecosystem service delivery in the farming system and in the NUTS3. This comparison gives an idea about whether the farming system increases or erodes resilience (its own resilience and the regional resilience), by adding or removing provision of ecosystem services.

However, we are aware that the indices used for this assessment rely on assumptions conceived to be meaningful at the large scale, and therefore, their analysis at the local scale might provoke distortions. This is why, once the analysis was performed, we submitted the results to case study leaders along with a questionnaire for driving the interpretation of results. Case study experts were required to confirm or to disagree with the results, according to their expertise (their own expertise or the expertise of colleagues). Such a questionnaire was aimed at bringing additional information to the ES assessment and, at the same time, to trigger a reflection about the relevance of the ecosystem services indices produced at the European scale by Maes et al. (2015).

15.4 METHODOLOGY

15.4.1 Proxies of ecosystem services

Proxies of ecosystem services were produced by the Joint Research Center and are freely available at https://data.jrc.ec.europa.eu/collection/maes. Metadata, as well as the methodology followed for producing the layers is described in Maes et al. (2011) and in Maes et al. (2015). The list of private and public goods, along with some details about definition, unit and year of the data, is provided in Table 15.1. Concerning private goods, the production of food crops, fodder crops, and energy crops, as well as the grazing livestock density are estimated using the CAPRI model (Common Agricultural Policy Regionalized Impact modelling system – www.capri-model.org) which is fed on EUROSTAT data, but provide estimates for missing data. The estimation of timber removal is based on the presence of forests.

Concerning public goods, proxies are based on different methodologies according to the definition. Concerning habitat quality based on common birds, the proxy is defined as species richness in relative term, i.e., as the ratio between local species richness and the average species richness in a 500 km radius. The proxy elaborates on the results of a species distribution model based on the maximum entropy (Phillips et al., 2006) starting from data of the EBCC (European Bird Census Council, www.ebcc.info) Atlas of European Breeding Birds. Concerning pollination, the proxy is based on the Relative Pollination Potential defined in (Zulian et al., 2013). This proxy is built on the Corine Land Cover map and it is based on the assumption that some land covers (mainly grassland and semi-natural land covers) are more suitable for habitat and nesting for pollinators (for this proxy only domestic bees are considered). Concerning forests, only the hedges are considered suitable for pollinator habitat. In the proxy also temperature and solar radiation are considered, as they affect insect metabolism. It is to be noticed that pesticide application is not considered in the proxy. Concerning water retention, the proxy consists in a composite indicator (ranging between 0 and 10) accounting for the presence of vegetation (for interception), the soil type and the presence of bedrock (for water-holding capacity and percolation), the soil sealing and the slope gradient. Concerning the organic matter in topsoil concentration, the proxy consists in an estimation of the percentage of total organic matter content and is calculated using information about the soil type, the topsoil texture class, the land use and the temperature. Concerning carbon storage, the proxy is based on the IPCC GPG Tier 1 approach which assigns default coefficients to different vegetation cover types regarding aboveground and belowground biomass. The carbon storage layer is based on the Global Land Cover 2000 project based on SPOT-VEGETATION satellite imagery for the year 2000. Concerning recreation potential, the proxy consists in the Recreation Potential Index (RPI) (Paracchini et al., 2014) which is based on the assumption that the recreation potential is positively correlated with the degree of naturalness of the land cover, to the presence of protected areas and of coastlines (lakes or sea). Also accessibility (proximity to cities and roads) is considered. Concerning NO_x deposition velocity the proxy is based on the capacity of the vegetation layer to capture and remove air pollutants. The proxy takes into account the presence of pollutants (estimated with an air quality model) and the presence of vegetation for which default parameters of deposition velocity are given

(Pistocchi et al., 2010). Concerning the capacity to avoid soil erosion, the proxy ranges from 0 to 1 and considers rainfall intensity, the soil type, the slope, and the type of vegetation (forests and grasslands are the most efficient).

Table 15.3 Definition of ecosystem service proxies according to Maes et al. (2015).

	Ecosystem service proxy	Unit (before standardization)	Definition	Year (of the data)
Public goods	Habitat quality based on common birds	Dimensionless	Capacity of ecosystems to be inhabited by birds (biodiversity)	2010
	Relative Pollination potential	Dimensionless	Relative capacity of ecosystems to support crop pollination	2010
	Water retention index	Dimensionless	Landscape's capacity to capture water, reducing runoff.	2010
	Organic matter in top soil concentration	%	Estimation of the total organic matter content as a % of dry fine earth fraction in each horizon.	2004
	Carbon storage	Ton/ha/year	Capacity of ecosystems to contribute to climate change mitigation.	2000
	Recreation potential	Dimensionless	Capacity of sites to provide recreation services based on their naturalness, level of protection and distance to lakes or the sea	2010
	Deposition velocity NOx	m/year	Capacity of vegetation to capture and remove air pollutants.	2000
	Capacity to avoid soil erosion	Dimensionless	Capacity of ecosystems to avoid soil erosion	2010
Private goods	Food crop production	1000 ton/100km²	Annual production of harvested food crops	2010
	Fodder crop production	1000 ton/100km²	Annual production of harvested fodder crops	2010
	Energy crop production	1000 ton/100km²	Annual production of harvested energy crops	2010
	Grazing livestock density	number heads/km²	Capacity of grasslands to support grazing livestock - Averaged number of grazing animals (sum of cattle, sheep and goat) per km².	2010
	Timber removal	100 m^3/km²	Quantity of timber removed in forests	2010

Data consisted of raster files (or rasterized shapefiles), i.e., matrices composed by squares, each one corresponding to a precise geographical location and characterized by a value of an ecosystem service. Layers were provided at different resolutions, ranging from 1 hectare to 100 km² (10 km by

10 km), but were rescaled to the common resolution of 10 km by 10 km. The definition of the ecosystem services represented in the different available layers are given in Table 15.1.

15.4.2 Indices standardization

Before analysing the ecosystem services provided in the different case studies, indices were standardized on a scale from 0 to 1. Being x the value of the proxy of ecosystem service observed in a cell, the corresponding standardized proxy x_S is obtained through the following equation:

$$x_S = \frac{x - x_{MIN}}{x_{MAX} - x_{MIN}} \quad \text{Eq. 1}$$

Where x_{MIN} and x_{MAX} represent the minimum value and the maximum value of the proxy observed in the whole layer (i.e., in all Europe). Thus, after standardization, the value of 0 corresponds to the minimum value observed in Europe and the value of 1 corresponds to the maximum value observed in Europe.

15.4.3 Data sampling in the case study

For each case study, we considered two levels of analysis:

- The NUTS3 (Nomenclature of Territorial Unit for Statistics – level 3) region(s) containing the farming system under study. The considered NUTS3 In Europe are depicted in Figure 15.2
- The specific area of the NUTS3 region(s) occupied by the farming system. Such area was previously identified with the help of a land use map and consultation/validation with case study partners. Within the NUTS3 of the different case studies, the area occupied by the farming system is depicted in Figure 15.3 along with the land uses taken from Corine Land Cover (European Environment Agency (EEA), 2019).

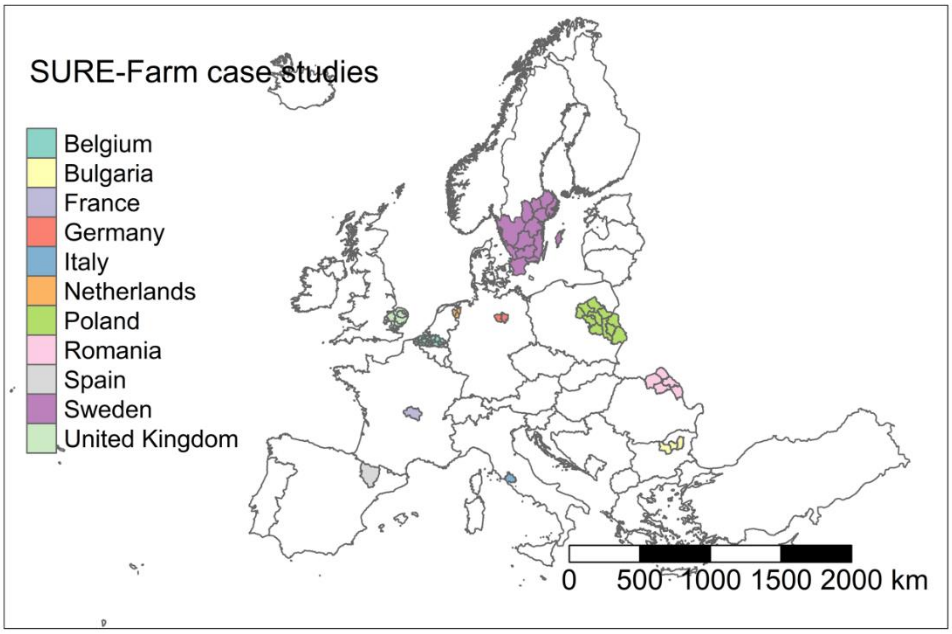


Figure 15.2. Representation of the NUTS3 regions containing the farming systems under study in the SURE-Farm project

Figure 15.3 shows that most of the area of the Belgian NUTS3 regions is occupied by cities. For such a case study, the 10-km-by-10-km squares were too biased by the presence of cities, therefore we decided not to do this analysis for the Belgian case study. Instead, for the other case studies, it was possible to find squares almost entirely occupied by the farming system and the indicators were judged representative of the land cover typical of the farming system.

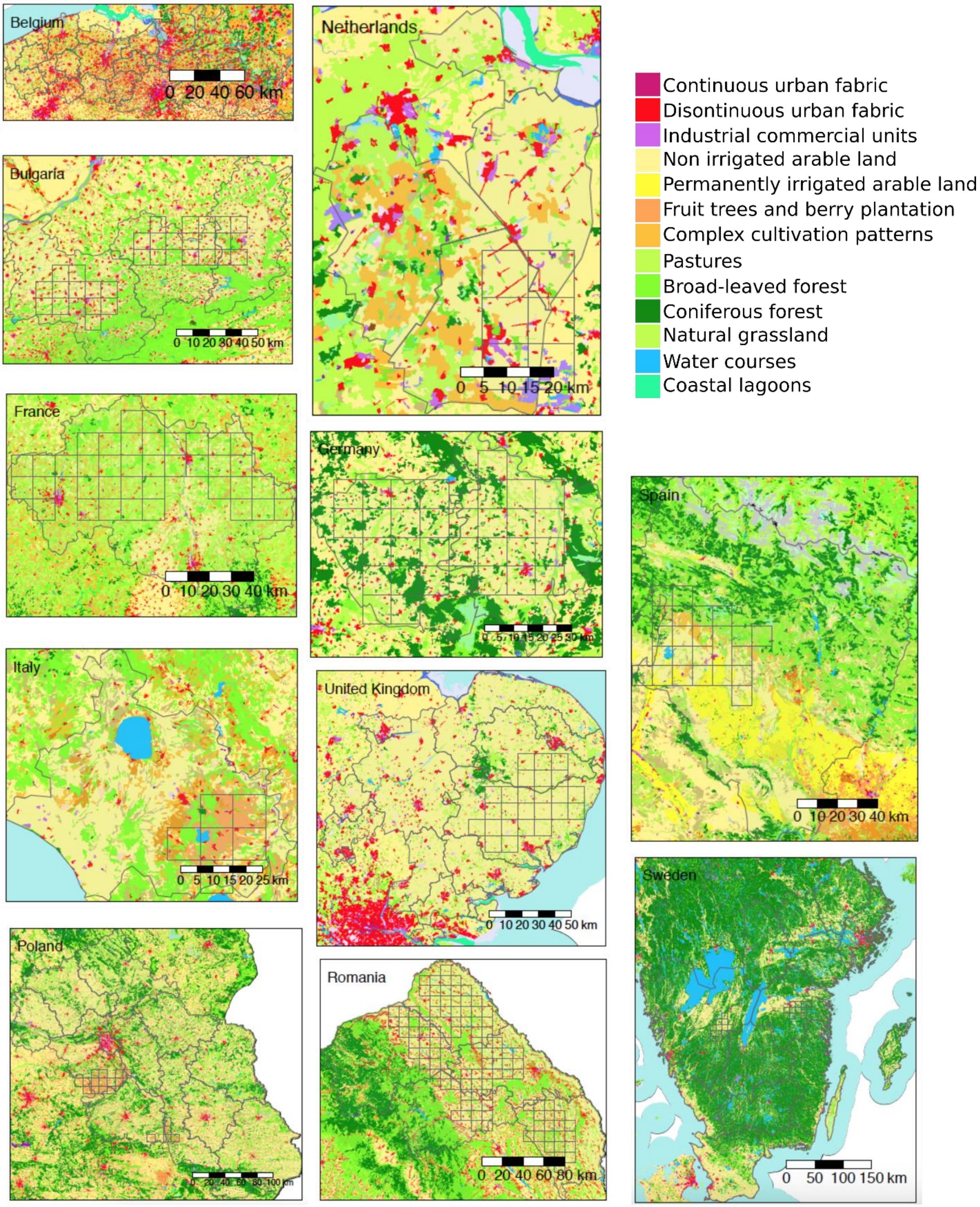


Figure 15.3. Representation of the zoom of each case studies with the NUTS3 region concerned, with representation of land uses based on the Corine Land Cover classification. The squares represent the area occupied by the farming systems.

Results were presented in forms of boxplots, for both private goods and public goods. They were presented at the NUTS3 level, with a comparison with Europe and at the farming system level, with a comparison with the NUTS3 level.

In the questionnaire provided to case study experts for agreeing or disagreeing, for each ecosystem services and comparison (NUTS3 vs Europe and farming system vs NUTS3), case study experts were asked to express their degree of agreement on the following scale: 1 (strongly disagree), 2 (disagree), 3 (agree), 4 (strongly agree). Along with the answer, case study experts were asked to provide an explanation. It was possible not to provide an answer in case the expert judged him/herself not having the expertise to answer or if not in the area of expertise for a particular ecosystem service.

15.5 RESULTS

Each 10-km-by-10-km square within the NUTS3 regions or within the farming system provides a certain value of ecosystem service. The distributions are presented in this section. Specifically, we highlight the comparisons of the distributions in Europe with all the NUTS3 regions of the case studies for private (Figure 15.4) and public (Figure 15.5) goods, and the comparisons of the distributions in the NUTS3 regions and in the farming systems for private (Figure 15.6) and public (Figure 15.7) goods. This section also provides a discussion about the results that found confirmation in the expert opinion, elaborating on the comments given by the expert on the questionnaire. The points of disagreement are discussed in the second part of this section, so they are not mentioned here.

15.5.1 Provision of private and public goods of NUTS3 regions in which farming systems are embedded

The results about the provision of public goods in the NUTS3 regions compared with Europe (Figure 15.4) show that most of the regions examined (except Sweden) tend to provide a higher crop production than the rest of Europe. Indeed, those regions are dedicated to agricultural production. The Bulgarian region provides food crops more or less in line with the European distribution, and has relatively low fodder crop production, grazing livestock and timber removal. Concerning the energy crop production, the distribution is higher compared to the rest of Europe and this might find confirmation in the recently increased interest in rapeseed due to the greening requirements and the policy encouraging the adoption of renewable energies. The French region presents a relatively low level of private goods compared to the other case studies with a modest level of energy crop production and timber removal, possibly due to the presence of hedges in the farming system and of forest in the Southern part of the region. The main good produced in the region is beef, which is not included in the analysis as livestock production is not included in the considered European database on ES provision. Hence, the grazing animal density is relatively high if compared to the other case studies and Europe, but much lower than in the Dutch case study as the French system is much more extensive. The German region presents a relatively high level of private goods except grazing animal density. The Italian region provides a relatively high amount of food crops and a level of other private goods slightly above the European average (except for timber removal). The Dutch region presents very high yields (starch potatoes is the farming system and grain and livestock in the rest of the region) and this could explain the very high performance in food production of this system. The relatively high fodder production is confirmed by a registered recent increase over time. Wheat is an important crop in the rotation to improve soil quality, and is mainly used as fodder. A relatively lower level of energy crop production might be explained by the fact that energy crops are less profitable and less subsidized than grain crops. Timber removal is extremely low as forest is very small and only 1% of the land is allocated to fast-growing timber. The Polish region performs above the European average for crop production and energy crops, and relatively poorly for fodder production and grazing livestock density. The Romanian region is average in Europe about all the private goods. For Spain (like France) the strong point is livestock production that is not included in the analysis. Fodder crop and timber removal is almost irrelevant. Grazing livestock is quite low because of the extensive nature of the sheep system. Concerning Sweden, the region is very intensive in forest and it is therefore logical that timber removal performs quite well. The British region is quite intensive in the production of crops, so the performance is relatively high both for crops and for fodder and particularly high for energy crop production; however it is quite low in grazing livestock and irrelevant in timber removal.

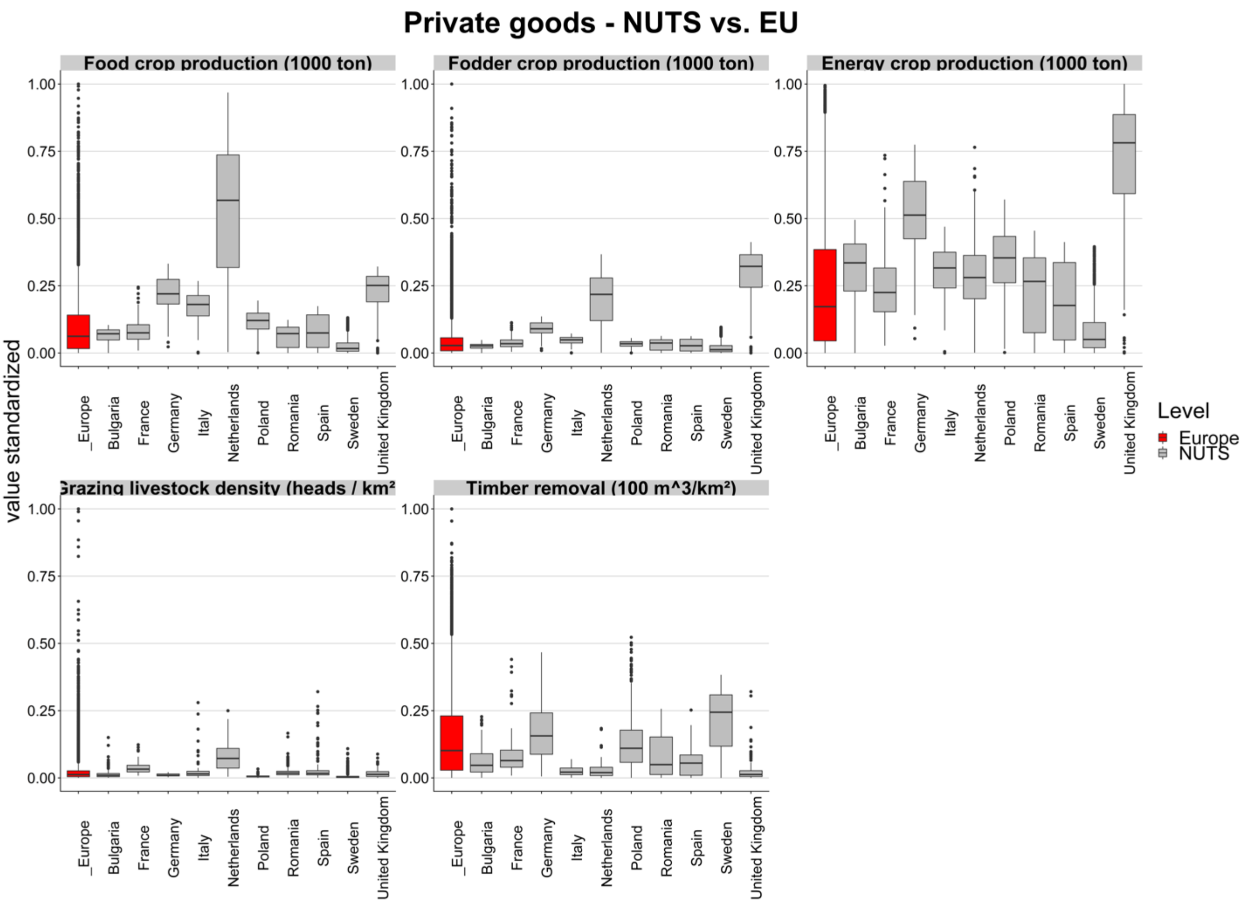


Figure 15.4 Box plots of the distributions of standardized proxies of private goods in the 10-km-by-10-km squares belonging to the different case study NUTS3 regions (grey boxes) compared with the distribution in Europe (red boxes).

The provision of public goods in the NUTS3 regions investigated is very variable in the different case studies (Figure 15.5). The Bulgarian region performs quite well in habitat quality, confirming its recognition as a region important for biodiversity and with extensive presence of the Natura 2000 network. The indices of carbon storage, NO_x deposition and soil erosion control are relatively low due to the presence of monocultures. For the French region the level of most public goods is moderate. Exceptions are the water retention proxy which spans a wide range of values due to the presence of different land uses (crops, forest and grassland) and capacity to avoid soil erosion, increased by the presence of grassland and forest. The landscape does not seem to be suitable for pollination as it lacks cultivation of plants supported by pollination. Concerning the low value of organic matter in the topsoil concentration, the low value might be explaining by the soil type and, in addition the only inputs of organic matter are the effluents of animals, this is not explicitly accounted for in the proxy, but it is an additional confirmation. The presence of grassland promotes carbon sequestration but does not store carbon in the soil. The low value of NO_x deposition is given by high presence of grassland that is less efficient than forest to remove pollutants from the atmosphere. The German region performs quite well in all the ecosystem services, spanning a wide range of values for recreation, due to the high presence of forests in the region. The Italian region performs relatively well in pollination potential due to the presence of fruit trees and semi-natural elements; however, it has a low performance in soil erosion control, probably due to the slope. In the Dutch region, habitat quality tends to be relatively low as the region is largely occupied by arable lands. The same can be said about pollination, which is indeed also hampered by the use of pesticides and the type of crops grown. The low level of carbon storage and NO_x retention capacity is due to the very low level of forest. The organic matter in topsoil concentration is relatively high. Concerning the Polish region, the production of ecosystem services is in line with the European average with a quite low level of pollination potential and a relatively high level of water retention proxy. For the Romanian region the pollination potential is low, and in addition (not accounted for in the proxy) it is known that pollination activity is low also because of the use of pesticides; the variability of water retention and carbon storage might be explained by the diversity of land types in the region, which includes plain, hills and mountains, almost equally distributed in the region. The Spanish region is mainly formed by shrubland and least-favored areas that perform relatively poorly in some ecosystem services (in particular capacity to avoid soil erosion, water retention, and NO_x retention capacity). However, its high degree of naturalness makes it possible to have high indices of pollination, habitat quality and recreation potential. The Swedish region is massively occupied by forests, so it performs quite well with all the ecosystem services provided by such a land cover (habitat quality, organic matter in topsoil concentration, carbon storage, NOx removal, capacity to avoid soil erosion); concerning pollination, the performance is low due to low temperatures and solar radiation. Concerning the British region, the high value of habitat quality can be based on birds specialized in arable lands. In the other ecosystem services, the region performs relatively fairly, with the exception of a good score in water retention.

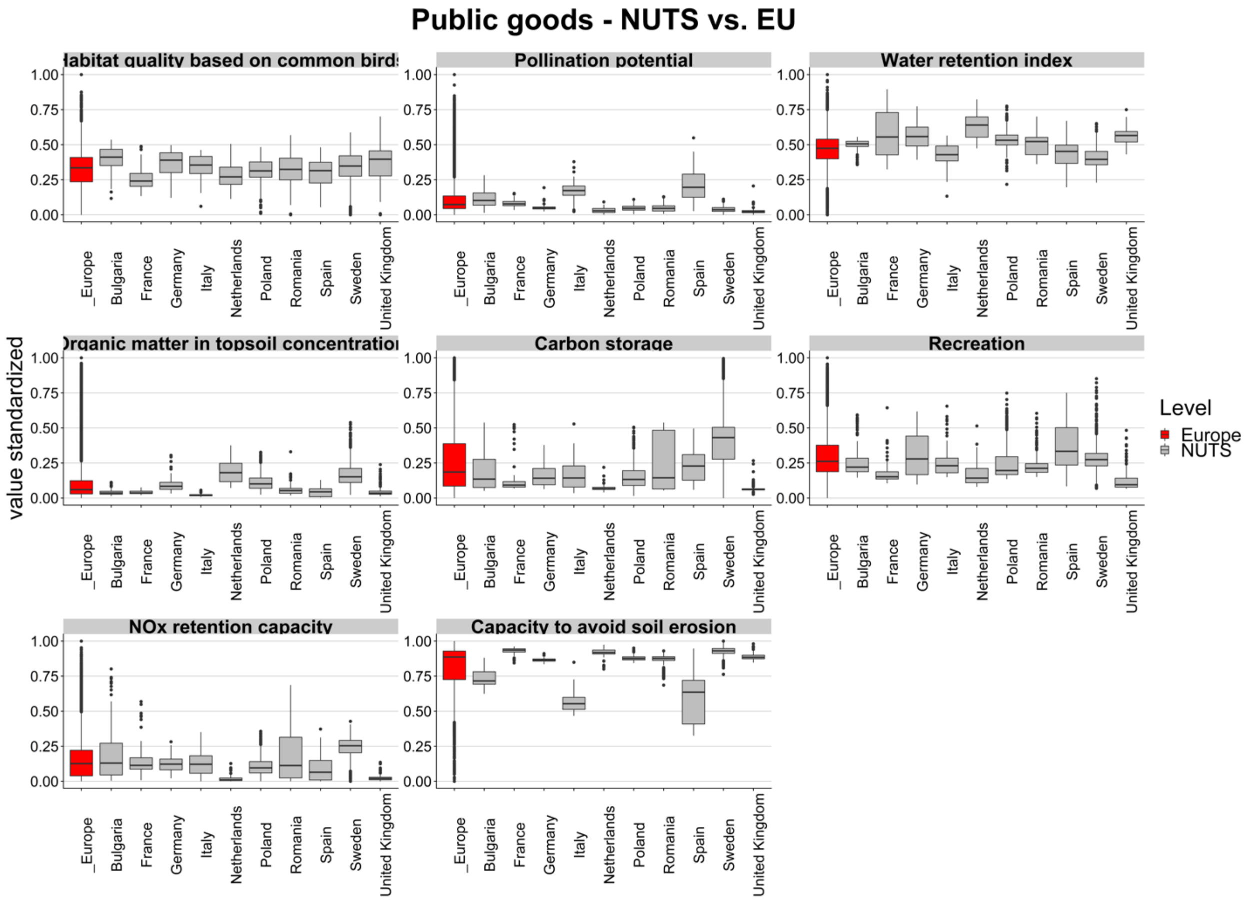


Figure 15.5. Box plots of the distributions of standardized values of public goods in the 10-km-by-10-km squares belonging to the different case study NUTS3 regions (grey boxes) compared with the distribution in Europe (red boxes).

Table 15.2 depicts the comparisons of the medians of the distribution of normalized ecosystem services indicators obtained in the NUTS3 regions containing the SURE-Farm case studies and the distribution obtained in the whole of Europe. Signs '+', '-', and '~', indicate that the median of the NUTS3 distribution is higher, lower, or comparable, respectively, with the median in Europe (if the difference between the two medians is lower than 0.05, then the symbol '~' is used, while if the difference between the two medians is higher than 0.05, the symbols '+' and '-' are used according to whether the median in the NUTS3 is higher or lower, respectively, than the median in Europe). Differences were statistically significant (t-Student test with significancy level = 0.1).

Table 15.2. – Comparison between the medians of the distributions of the normalized ecosystem services indicators in the NUTS3 regions in each case study and the rest of Europe. '+' indicates that the median of the distribution in the NUTS3 region is higher than the median of the distribution in the rest of Europe (difference higher than 0.05), '-' indicates that the median of the distribution in the NUTS3 region is lower than the median of the distribution in the rest of Europe; '~' indicates that the medians of the NUTS3 and Europe distribution are similar (difference lower than 0.05). All the differences are checked statistically significant.

		RO	IT	PL	UK	NL	DE	BG	FR	ES	SE
Private goods	Food crop production	~	+	+	+	+	+	+	+	+	-
	Fodder crop production	~	+	~	+	+	+	~	~	~	-
	Energy crop production	+	+	+	+	+	+	~	+	~	-
	Grazing livestock density	~	~	~	~	+	~	-	+	+	~
	Timber removal	-	-	~	-	-	+	-	-	-	+
Public goods	Carbon storage	~	-	-	-	-	-	-	-	+	+
	Habitat quality index	-	+	-	+	-	+	+	-	-	+
	NOx deposition	~	~	-	+	-	~	+	-	-	+
	Organic matter concentration in topsoil	-	-	+	-	+	+	-	-	-	+
	Relative pollination potential	-	+	-	-	-	-	+	~	+	-
	Recreation potential	-	-	-	-	-	+	-	-	+	+
	Soil erosion control	~	-	~	~	+	-	-	+	-	+
	Water retention index	+	-	+	+	+	+	+	+	-	-

15.5.2 Provision of private and public goods of farming systems in context of the NUTS3 region

The comparison between the ecosystem services provided in the farming system and the rest of the NUTS3 regions makes it possible to investigate the capacity of the farming system to provide or to detriment some functions to the region within which it is embedded. Concerning the provision of private goods (Figure 5) almost all the farming systems add some production to the rest of the respective regions, which are, in general already performing higher than the European averages. The same cannot be said for timber removal. The farming systems are, indeed by definition, areas that provide private goods and in most case studies the agricultural production is concentrated in the farming system area. For the Romanian case study the grazing livestock is mostly concentrated in the hilly regions outside the farming system. For the Dutch case study the agricultural production is mainly composed by starch potatoes, sugar beet and wheat, and this rotation is more intensive than in the rest of the region. The French farming system performs lower than the rest of the region in crop production as it is mainly focused on grassland-based extensive livestock.

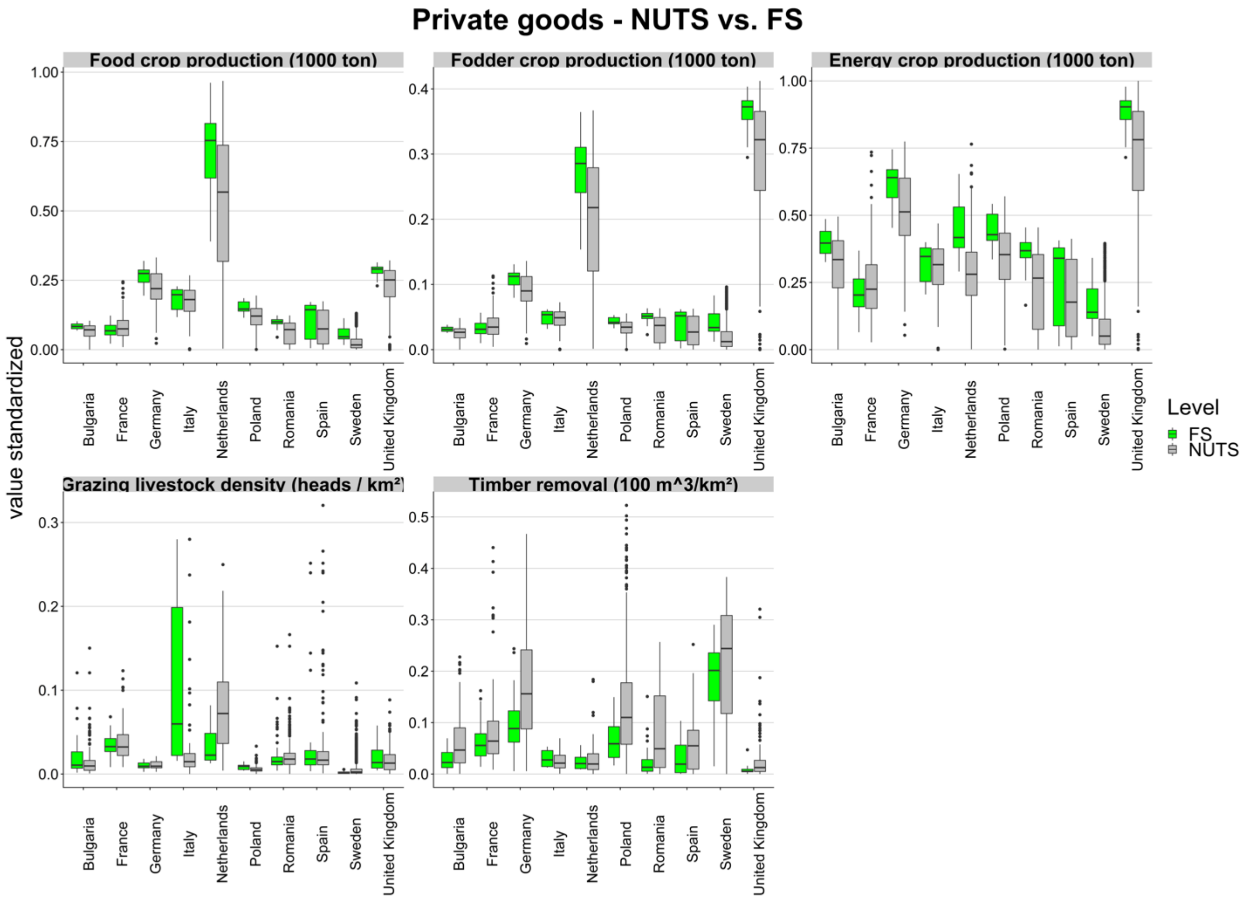


Figure 15.6. Box plots of the distributions of standardized values of private goods in the 10-km-by-10-km squares belonging to the different case study NUTS3 regions (grey boxes) compared with the distribution in 10-km-by-10-km squares belonging to the farming system (green boxes).

The case studies show diverse behaviors concerning the provision of public goods (Figure 15.7). In the Bulgarian case study the farming system lowers the provision of habitat quality. Indeed the areas designated for bird conservation are in the part of the region outside the farming system. Water retention is mostly in line with the rest of the region. Concerning organic matter in the soil, while the value at the regional level is questioned, the value in the farming system is accepted because of the presence of monocultures. Also the recreation potential is lower if compared with the rest of the region. The French case study tends to increase the habitat quality in the rest of the region as grassland might favor habitat for birds. The farming system increases the capacity to avoid soil erosion but at the same time decreases the pollination potential (higher in other areas of the region), NO_x removal, organic matter concentration in the topsoil, and carbon storage. The German farming system increases habitat quality, however it tends to decrease all other ecosystem services. The Italian farming system tends to increase pollination potential, the capacity to avoid soil erosion and carbon storage as permanent crops tend to promote those ecosystem services. The Dutch case study lowers almost all the ecosystem services, as the farming system is quite intensive and the main natural land covers, even if not many, are located outside the area. The only ecosystem service in which the Dutch farming system provides a contribution in the region is water retention as other parts of the region have problems of water retention because of sandy soils. However, the absolute value seems too high and it was questioned by the expert. Concerning the Polish case study, it seems that the farming system performs slightly lower than the rest of the region in most ecosystem services, in particular for habitat quality, recreation potential. In the Romanian case study, the farming system lowers the habitat quality and pollination potential as birds and pollinators are mostly located in the mountain area of the region and pesticides are used in the farming system. Water retention is higher because of the plain ground level. Also recreation potential, NO_x retention, and carbon storage are lowered. In fact, tourist attractions are located elsewhere and the farming system is cultivated only during a part of the year, limiting the potential for carbon storage. The Spanish farming system improves the habitat quality, increases the variability of pollination potential and increases water retention. Carbon storage, recreation potential, NO_x removal and the capacity to avoid soil erosion are worse than in the rest of the region as grassland and forest covers are mainly located outside the farming system areas. The Swedish case study tends to decrease the provision of most public goods. Concerning UK, the habitat quality is increased, as well as the pollination potential (even though the absolute values are low). Recreation potential is relatively low even though the questionnaire revealed that it could be higher, as some SURE-Farm activities (namely the FoPIA-SURE-Farm workshop) highlighted a recent development of agro-tourism.

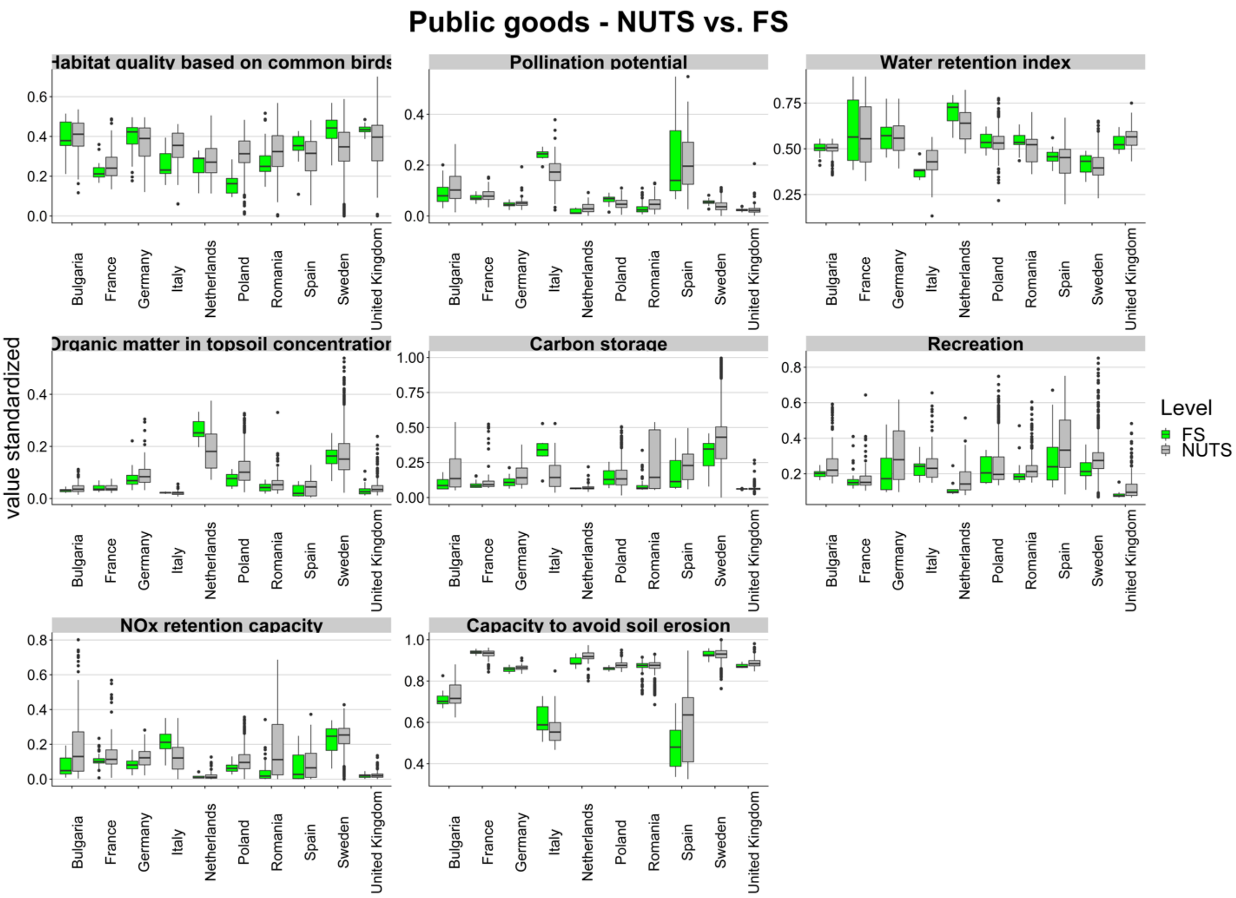


Figure 15.7. Box plots of the distributions of standardized values of public goods in the 10-km-by-10-km squares belonging to the different case study NUTS3 regions (gray boxes) compared with the distribution in 10-km-by-10-km squares belonging to the farming system (green boxes).

Table 15.3 depicts the comparisons of the medians of the distribution of normalized ecosystem services indicators obtained in the farming system area compared to the NUTS3 regions containing farming system itself. This allows investigating the capacity of the farming system in promoting or decreasing ecosystem services multi-functionality to the surrounding region. Signs '+', '-', and '~', indicate that the median of the farming system distribution is higher, lower, or comparable, respectively, with the median in the NUTS3 (if the difference between the two medians is lower than 0.05, then the symbol '~' is used, while if the difference between the two medians is higher than 0.05, the symbols '+' and '-' are used according to whether the median in the NUTS3 is higher or lower, respectively, than the median in Europe). Only a very few differences were found statistically significant (t-Student test with significance level of 0.1), so we decided to indicate the comparisons among the medians (farming system and NUTS3) and to indicate which differences were statistically significant.

Statistically significant relationships were found for crop production in the Netherlands, where the farming system is more productive than in the rest of the NUTS3. In the Romanian farming system statistically significant relationships were found for carbon storage, habitat quality proxy, and NO_x deposition, for which the performance was lower than the rest of the region. Also the proxy of energy crop production showed a statistical positive difference for some case studies (Romania, Poland, UK), however this proxy was questioned by more than one case study expert.

Among case studies, the Italian farming system seems to bring more public goods to the rest of the region, making it the most multifunctional system among the case studies. Sweden showed the opposite trend as it tends to perform badly in public goods, showing that the farming system is very much in contrast with the forested rest of the region, as it consists of intensive poultry production.

Table 15.3 – Comparison between the medians of the distributions of the normalized ecosystem services indicators in the farming systems for each case study and the NUTS3 region the farming system belongs to. '+' indicates that the median of the distribution in the farming system is higher than the median of the distribution in NUTS3 (difference higher than 0.05), '-' indicates that the median of the distribution in the farming system is lower than the median of the distribution in the NUTS3; '~' indicates that the medians of the farming system and NUTS3 distribution are similar (difference lower than 0.05). Statistically significant differences are indicated with '' (Bonferroni test with significance level = 0.1).*

		RO	IT	PL	UK	NL	DE	BG	FR	ES	SE
Private goods	Food crop production	~	~	~	~	+*	+	~	~	~	+
	Fodder crop production	~	~	~	~	+	~	~	~	~	~
	Energy crop production	+*	~	+*	+*	+	+	+	~	+	+
	Grazing livestock density	~	~	~	~	~	~	~	~	~	~
	Timber removal	~	~	-	~	~	-	~	~	~	~
Public goods	Carbon storage	-*	+	~	~	~	~	~	~	-	-
	Habitat quality index	-*	-	-	~	~	~	-	~	+	~
	NOx deposition	-*	+	~	~	~	~	-*	~	~	~
	Organic matter concentration in topsoil	~	~	~	~	+	~	~	~	~	~
	Relative pollination potential	~	+	~	~	~	~	~	~	~	-
	Recreation potential	~	~	~	~	~	-	~	~	-	-
	Soil erosion control	~	~	~	~	~	~	~	~	~	-
	Water retention index	~	~	~	~	-	~	~	~	~	~

15.5.3 Comparison between NUTS3 and Europe accounting for expert opinion

The results of the assessment at the NUTS3 level compared to the rest of Europe was submitted to experts of the case study area and some corrections were done to Table 15.2, resulting in Table 15.4. This section reports, case study by case study, the points of disagreement given by the expert about Table 15.2 (or Figures 15.4 and 15.5). If the case study is not reported, it means that there were no points of disagreement.

Romania

The proxy of habitat quality seems to underestimate the rich biodiversity that the Romanian NUTS3 has, therefore a correction was suggested. The recreation potential should also perform better. Indeed there are not many developed tourist or recreation opportunities in the region, however, still the region has good potential for recreation. Concerning the soil erosion control, the region should not perform so well as recently some massive forest cut was done, exposing the system to erosion.

Poland

The proxy of recreation potential is lower than the rest of Europe, however it should be even lower in absolute number as fruit trees do not have a good recreation potential.

The Netherlands

The soil water retention proxy tends to overestimate the real performance of the region. The soil erosion control performs way to high compared to the rest of the Europe and indeed it should be at least at the same level. Concerning grazing density, even though the value is the highest among all the case studies, it seems too low compared to reality.

Germany

The proxy of water retention seems to overestimate the real potential of the system. The rainfall distribution is unfavorable all over the year, leading soils to be too dry in summer and too wet in early spring.

Bulgaria

Concerning relative pollination potential, the region should perform better as it has high biodiversity compared to the rest of Europe. However, the low level of relative pollination potential can be explained by the presence of wide grain crop fields in the region. The organic matter concentration in the soil should perform better, having in mind that the region has the most fertile soils in Europe. A reason for low level of performance in this indicator could be the development of monocultures in the last 10-15 years, however there are some practices by farmers that started to re-enrich the soil (e.g., CAP greening requirements, no-till technologies).

France

The recreation potential proxy seems to underestimate the real situation. Indeed the grassland landscape with hedges is very typical of the farming system and it is promoted by policies because of the good aesthetic qualities. In the southern part of the NUTS3 region there are some forests that should contribute to increase the proxy.

Spain

In Spain, it seems that energy production is higher than expected in comparison with the rest of Europe.

Table 15.4 – This table corresponds to Table 1 with some corrections (indicated with 'C') given by the case study expert responding to the questionnaire. '+' indicates that the median of the distribution in the NUTS3 region is higher than the median of the distribution in the rest of Europe (difference higher than 0.05), '-' indicates that the median of the distribution in the NUTS3 region is lower than the median of the distribution in the rest of Europe; '~' indicates that the medians of the NUTS3 and Europe distribution are similar (difference lower than 0.05).

		RO	IT	PL	UK	NL	DE	BG	FR	ES	SE
Private goods	Food crop production	~	+	+	+	+	+	+	+	+	-
	Fodder crop production	~	+	~	+	+	+	~	~	~	-
	Energy crop production	+	+	+	+	+	+	~	+	-C	-
	Grazing livestock density	~	~	~	~	+C	~	-	+	+	~
	Timber removal	-	-	~	-	-	+	-	-	-	+
Public goods	Carbon storage	~	-	-	-	-	-	-	-	+	+
	Habitat quality index	+C	+	-	+	-	+	+	-	-	+
	NOx deposition	~	~	-	+	-	~	+	-	-	+
	Organic matter concentration in topsoil	-	-	+	-	+	+	+C	-	-	+
	Relative pollination potential	-	+	-	-	-	-	+	~	+	-
	Recreation potential	+C	-	-	-	-	+	+C	+C	+	+
	Soil erosion control	-C	-	~	~	~C	-	-	+	-	+
	Water retention index	+	-	+	+	-C	-C	+	+	-	-

Overall, after the proposed corrections of the experts, some regions (Romanian, Bulgarian, and French NUTS3 regions) seem to perform better in the real situations than according to the information provided by the proxy. Main areas for disagreement by the experts in these case studies regarded the areas of pollination, biodiversity and recreation potential. Indeed, these indices might not capture the real complexity of the function and ignore some points, like practices for increasing pollination potential or characteristics of the landscape of high recreation potential which are not based strictly on land use. After correction, the Dutch NUTS3 region seem to perform less well in the provision of public goods.

15.5.4 Comparison between farming systems and NUTS3 accounting for expert opinion

The comparison between the distribution of ecosystem services indicators in the farming system and in their NUTS3 region was submitted to case study experts and some corrections were done to Table 15.3, resulting in Table 15.5. In this section we report the main points of disagreement to Table 15.3 (and Figures 15.6 and 15.7) by the case study experts. If comments are not reported for a case study, it means that no major points of disagreement were raised.

Italy

The indices of organic matter concentration in the soil and recreation potential seem to underestimate the real performance of the farming system compared to the rest of the NUTS3 region. Timber removal should be lower in the farming system than the rest of the NUTS3 as hazelnut production is not exploited for timber production, while in the rest of the regions there are chestnut cultivations which are subject to cuts due to the good quality of the timber.

Poland

The recreation potential proxy is questioned as the fruit cultivation is not interesting for recreation purposes nor for aesthetic qualities.

UK

Concerning carbon storage, organic matter concentration in topsoil, and soil erosion control, the indices in the farming system seem quite low. In particular, the index does not account for some practices made by farmers (in contrast to the rest of the region) aimed at preserving soil conditions in a region where intensive crop production is the dominant paradigm. Practices consist in conservation agriculture, for example in no-tillage (which receive greening subsidies), and cover crops. The farming system produces mainly feed and food crops, therefore the energy crop proxy seems way too high and should be corrected.

The Netherlands

The soil erosion overestimates the performance of the farming system as there are problems related to wind erosion which seem not to be accounted for in the proxy. In addition, the organic matter in the soil is mostly inactive and does not bind sand particles. There is some adaptation by farmers who leave straw in the field and avoid ploughing. Fodder crop production seems too high for the farming system compared to the rest of the region, based on country-level data.

Germany

The soil water retention proxy should be lower due to the sand and clay soil and unfavorable rainfall distribution within the year.

Bulgaria

The relative pollination potential seems to be quite low especially considering that in the study area there are some infrastructures for facilitating pollination. The proxy is higher than the rest of the region, but it remains too low anyways according to the case study expert. Concerning carbon storage, the proxy seems to underestimate the performance of the farming system as the landscape has a very good potential for carbon storage and climate change mitigation, given the presence of forests and sparse vegetation. The NO_x removal proxy is too low considering the presence of vegetation and the absence of air polluting activities in the surrounding area. The food crop production proxy should perform much better as the system has the most crop diversified area in the region.

France

Concerning the water retention proxy, while there could be agreement about the comparison between the medians, there is disagreement about the fact that the values of the proxy span the same range in the farming system and in the NUTS3, while land covers are quite different. The lower performance of carbon storage is surprising as the grassland present in the farming system should promote this function better than in arable areas, but maybe the presence of forests in the southern part of the department can explain this result. The recreation potential should be higher than in the rest of the region and the aesthetic quality of the landscape is very valuable. Also for the French case study, the high level of energy crop production is questioned.

Table 15.5 – This table corresponds to Table 3 with some corrections (indicated with 'C') given by the case study expert responding to the questionnaire. '+' indicates that the median of the distribution in the farming system is higher than the median of the distribution in NUTS3 (difference higher than 0.05), '-' indicates that the median of the distribution in the farming system is lower than the median of the distribution in the NUTS3; '~' indicates that the medians of the farming system and NUTS3 distribution are similar (difference lower than 0.05).

		RO	IT	PL	UK	NL	DE	BG	FR	ES	SE
Private goods	Food crop production	~	~	~	~	$+^{*}$	+	~	~	~	+
	Fodder crop production	~	~	~	~	+	~	~	~	$+^{C}$	~
	Energy crop production	$+^{*}$	~	$+^{*}$	$+^{*}$	+	+	+	~	+	+
	Grazing livestock density	~	~	~	~	~	~	~	~	~	~
	Timber removal	~	$-^{C}$	-	~	~	-	~	~	~	~
Public goods	Carbon storage	$-^{*}$	+	~	$+^{C}$	~	~	$+^{C}$	$+^{C}$	-	-
	Habitat quality index	$-^{*}$	$+^{C}$	-	~	~	~	-	~	+	~
	NOx deposition	$-^{*}$	+	~	~	~	~	$+^{C}$	~	~	~
	Organic matter concentration in topsoil	~	$+^{C}$	~	$+^{C}$	+	~	~	~	~	~
	Relative pollination potential	~	+	~	~	~	~	$+^{C}$	$+^{C}$	~	-
	Recreation potential	~	$+^{C}$	$-^{C}$	~	~	-	~	$+^{C}$	-	-
	Soil erosion control	~	~	~	$+^{C}$	$-^{C}$	~	~	~	~	-
	Water retention index	~	~	~	~	-	$-^{C}$	~	~	~	~

15.6 CONCLUDING REMARKS

15.6.1 Concluding remarks on the ecosystem services multi-functionality of the SURE-Farm farming systems

The analysis of the different farming systems considered in the SURE-Farm project (excluding Belgium for the impossibility to apply the methodology), made it possible to have an idea about the contribution of farming systems to bring or detriment multi-functionality to the region they belong to. While for all the case studies the farming system provides a net contribution in relation to at least one private good, the situation can be quite different when public goods are considered. In some cases, the farming systems bring functions into the region and contribute to their own resilience (at least for the aspects of resilience connected to ecosystem services multi-functionality and the natural capital) and the resilience of the region. In other cases, the system seems disconnected with the surrounding region and constitutes a separated island of provision of private goods at the detriment of public goods.

15.6.1.1 Farming systems adding multi-functionality to the surrounding region

We argue that the following case studies are quite multifunctional and bring a number of public functions in the region along with the provision of private goods: UK, Italy, France, Spain. In the case of UK, the analysis of the ecosystem services indicators and the answers given to the questionnaire highlighted that the farming system is contributing to bring beneficial multi-functionality in a region otherwise characterized by a low multi-functionality. In particular, this occurs thanks to the implementation of some local practices not captured by the proxy but highlighted by the expert's responses to the questionnaire. Such practices are specifically aimed at increasing some public functions, for example no-till and cover crops for preventing soil erosion or development of agro-tourism for increasing the recreation potential. The Italian case study seems to provide multi-functionality because of the intrinsic capability of hazelnut cultivation to contribute to ecosystem services. Such a farming system is indeed capable to provide good habitat quality, carbon storage, and NO_x removal. For France and Spain it seems that the farming system is somehow separated by the rest of the region, but provides its own set of public functions that, summed to the complementary public functions provided by other land uses in the region, contribute to a diverse and multifunctional region. In particular, the French farming system brings carbon storage, recreation potential and pollination, in a region where also crops and forest are present, providing different and complementary public and private goods. As for Spain, the farming system brings habitat quality and soil water retention, while the provision of other ecosystem services remains in the rest of the region where forests and grasslands are located.

15.6.1.2 Farming systems removing ecosystem services from the surrounding region

We argue that the following farming systems constitute a separated island of provision of private goods at the expense of the provision of public goods: Bulgaria, Poland, the Netherlands, Germany, and Sweden. These systems constitute a separation from the surrounding region, they tend not to integrate public goods with private goods and compete for land use with the surrounding region that, in turn tends to provide some multi-functionality or can be already poor of public goods. Concerning Bulgaria, although in the system there are practices to improve pollination potential, the system is composed by monoculture with lower erosion control, water retention proxy, and organic matter in topsoil concentration. As for habitat quality, the conservation projects are all located outside the farming system. Concerning Romania, the farming system is located in a region with other, well separated areas, a mountain and a hilly area. The farming system lowers most ecosystem services, in particular carbon storage, habitat quality and NO_x deposition. Concerning the Netherlands and Poland, results show that the farming system decrease public good multi-functionality in a region already characterized by poor multi-functionality. The Dutch farming system does not contain grassland or forest and has problems related to wind erosion. The Polish farming system decreases the habitat quality and the recreation potential without bringing any relevant contribution in any of the public goods. The Germany case study tends to remove functions to a region characterized by a moderate multi-functionality, in particular, recreation potential and water retention proxy are the most decreased. The Swedish case study constitutes a very intensive system, clearly separated by the surrounding forest, which provides a high level of multi-functionality.

15.6.2 Concluding remarks on the methodology

In our analysis we used indices from publicly available datasets (the most up-to-date quantitative information about ecosystem services at the European scale), refined with inputs from experts that know the regions concerned. The indices were conceived to make assessments at the large scale (countries to Europe) and, indeed, in many cases, they were confirmed by the experts' opinions. In some cases, however, the indices missed to take into account some relevant information to be well representative at the local scales. The main reasons for disagreement of the experts to the indices values were due to the following reasons: (i) the proxy is not able to account for some practices put in place locally to improve the provision of ecosystem services, such as no-till for preventing soil erosion or infrastructure for improving pollination potential; (ii) the proxy was simply not up-to-date for including some recent changes in the system; (iii) the proxy, for the assumptions upon which it is based, did not take into account some relevant aspects of the phenomenon, such as wind erosion or elements of recreation not strictly based on land cover. In addition, the proxy of energy crop production was questioned more than one time by the experts.

This assessment teaches a lesson about the relevance of large-scale indices of ecosystem services for investigating on the multi-functionality of farming systems. We believe that those indices are not always accurate and their values should be carefully examined by experts before drawing conclusions at the local scale. However, these indices have the merit to trigger discussions and reflections for a better knowledge of the farming systems and their surrounding regions. We believe that our analysis can still be improved with further investigation (e.g., consultation with more experts or even local stakeholders, bibliographic research, use of complementary data). However, it already gives at least a high-level idea of the characterization of different farming systems in relations to ecosystem service multi-functionality.

16 RESILIENCE OF FARMING SYSTEMS: WHY A NEW FRAMEWORK WAS NEEDED

Miranda Meuwissen, Alisa Spiegel, Wim Paas, Pytrik Reidsma

The novelty of the SURE-Farm framework is that it addresses three aspects simultaneously, i.e. (i) it studies resilience at the farming system level, (ii) considers three resilience capacities, and (iii) assesses resilience in the context of the (changing) functions of the system. The use of multiple qualitative and quantitative methods allows to provide a lot of nuance to the resilience question. What can be concluded based on the current resilience assessment across the eleven case studies? This synthesis distinguishes between results, methods and further research. Results are synthesized around the three aspects (i)-(iii) characterizing the SURE-Farm framework.

16.1 RESULTS

Many actors are part of the farming system. However, resilience-enhancing strategies are mostly defined at the farm level.

In each farming system, multiple actors are considered to be part of the system, such as consultants, neighbors, local selling networks and nature organizations. The number of different farming system actors beyond the focal farmers varies between 4 (in French beef and Italian hazelnut systems) and 14 (large-scale arable systems in the UK). These large numbers of actors illustrate the relevance of looking at farming system level rather than at farm level. It also suggests that discussions about resilience and future strategies need to embrace all of these actors.

Yet, results show that suggested future strategies to enhance resilience mostly focus on farm level, such as improved access to technology and alternative succession models which go beyond family structures. For other system actors, only few suggestions are made, e.g. for value chain actors to cooperate with farmers on a more fair basis, and for banks and insurers to share their in-depth knowledge about risks with farmers more transparently. In systems where (local) governments are part of the system, there are also future strategies for them, such as in Germany where suggestions were made towards financial support to deal with climate chance and a reduction of rigidity and bureaucracy.

Farm level strategies are the type of strategies farmers, and also other stakeholders, first come up with. These were also the ones that led to robustness and adaptability in the past. The question is whether farmers don’t realize how other strategies have contributed in the past, whether they focus on farm level strategies because this is where they think they can act, or whether new strategies at other levels are needed in the future.

At system level there is a low perceived capacity to transform. Yet, most systems appear to be at the start of a period in which (incremental) transformation is required.

At system level, the capacity to transform is perceived to be relatively low, except in the Romanian mixed farming system. The latter may reflect a combination of ample room to grow and a relatively stable environment (especially when compared to the past 30 to 50 years). The relatively low capacity to transform in the majority of systems is not in line with the suggestion that most systems are at the start of (incremental) transformation, or, at least, reached a situation in which they can no longer grow. Further growth is only deemed possible in the Belgium dairy, Italian hazelnut, Polish fruit and Romanian mixed farming systems.

Although the capacity to transform is perceived as low, the recent past has shown ample examples of system *adaptation*. For instance, in the Dutch arable system, farmers could cope with declining EU subsidies due to innovations at the cooperative level which led to increased value added of potatoes and thereby sustained farm incomes.

Then why is (incremental) transformation at system level perceived as more difficult? Suggestions might be found in 'the status' of attributes – as many were found to be constraining, such as low profitability preventing farmers from experimentation for Dutch arable farmers, low openness for cooperation among Polish fruit farmers, low to no connection outside the farming system in the Italian hazelnut system, and succession problems apparent in many systems. Also, a number of attributes were found to enhance robustness but at the same time constrain transformability, such as strong mutual dependence between farmers and other actors in the chain. This was observed in multiple systems. At the same time, stakeholders do not agree on which attributes contribute to transformability. So, it is not so easy to say that when an attribute scores low, this impedes or improves transformability. For example, while succession problems were apparent, and argued to limit transformability, the moment of farm succession or a farm-exit provides the best opportunities for transformation at farm level, and possibly at farming system level as well.

A further explanation for low transformability might be the accumulation of challenges; while systems were used to deal with economic and institutional challenges in the past, all systems now report increasing social and environmental challenges. The latter include among others the occurrence of extreme weather events, low soil quality, water scarcity, new pests, and nematodes. Also social challenges are many, such as lack of infrastructure, low attractiveness of the region and public distrust in the German arable farming system, and emigration of young people and a too tolerant social aid legislation in the Romanian system. Problems related to farm demographics, low attractiveness of the rural area, and public distrust apply to most systems. In the Netherlands and Belgium these are augmented with feelings of shame to be a farmer and more generally low attractiveness of farming as a profession. Although accumulating challenges might hinder perceived capacity to transform, they also trigger the need for transformation.

At the farm level, transformability (as well as the other resilience capacities) is suggested to be better than at farming system level. Although this might 'just' be a matter of scale (it is less complex to transform a farm compared to a whole system), it is interesting to understand what is needed to scale up the transformability capacity from the farm level to the system level.

System functions score well with regard to the delivery of high-quality and safe food but face problems with quality of rural life and protecting biodiversity.

Resilience capacities can only be understood in the context of the functions to be delivered by a farming system. We find that across all systems required functions are a mix of private and public goods. With regard to the capacity to deliver private goods, all systems perform well with respect to high-quality and safe food. Viability of farm income is regarded moderate or low in the livestock systems in Belgium (dairy), France (beef) and Sweden (broilers), and the fruit farming system in Poland. Across all functions, attention is especially needed for the delivery of public goods. More specifically the quality of rural life and infrastructure are frequently classified as being important, but currently performing bad.

Despite the concerns about the delivery of public goods, many future strategies still focus on improving the delivery of private goods. Suggestions in the area of public goods include among others the implementation of conservation farming in the UK arable system, improved water management in the Italian hazelnut system, and introduction of technologies which reduce the use of herbicides in Polish fruit systems. It is questionable whether these are sufficient to address the need to improve the maintenance of natural resources, biodiversity and attractiveness of rural areas.

With regard to the changing of functions over time, we did not find evidence for this in our farming systems.

16.2 METHODOLOGICAL CONSIDERATIONS

From 'challenges' to 'perturbations'?

Our resilience assessment focused on environmental, economic, social and institutional challenges. However, during the field work we also retrieved insight into system change due to *opportunities*, such as the introduction of agro-environment stewardship scheme in the UK as an opportunity to improve biodiversity, the opportunity to buy herds of exiting farmers at relatively low prices in Spain, and the availability of improved quality seed potatoes and varieties resistant to nematodes in the Netherlands. Insight into system change due to such opportunities broadens the understanding of resilience capacities. Challenges and opportunities can be captured under the umbrella term of perturbations. Many transformations take place because of opportunities (along with challenges). Farmers and other actors need to see an opportunity to invest. For example, Termeer et al. (2019) described the transformation of livestock farming in the southern part of the Netherlands following the opportunities to buy cheap compound feed and to export to other EU countries.

Interpretation of robustness, adaptability and transformability is relative to context and perspective

Resilience capacities have been defined as follows (Meuwissen et al., (2019); see also section 3.5):

- Robustness is the farming system's capacity to withstand stresses and (un)anticipated shocks.
- Adaptability is the capacity to change the composition of inputs, production, marketing and risk management in response to shocks and stresses but without changing the structures and feedback mechanisms of the farming system
- Transformability is the capacity to significantly change the internal structure and feedback mechanisms of the farming system in response to either severe shocks or enduring stress that make business as usual impossible. Such transformations may also entail changes in the functions of the farming system.

The exact interpretation of these capacities seems to be dependent on the regional and country context. For instance, farmers in Eastern EU farming systems (case studies in Poland, Romania, Bulgaria and Germany) went through many changes (end of communism, democratic renewal, accession to EU, scale enlargement) in the recent past which forced them to frequently adapt. Therefore, their interpretation of 'transformability' seems to be related with more drastic changes than for farmers in other EU regions. In general, robustness is more associated to the short term, adaptability to the medium term, and transformability to the long term. However, when transformations are experienced in the past (or pending as in the UK case study), transformation may become a more medium or even short term possibility. The interpretation of 'transformability' also depends on the stakeholder's perspective. The starch potato cooperation in the Dutch case study considers the change in the factory to process more high-value products from the starch potato as a transformation. However, the farm plans and associated system functions did not change much and therefore the farming system has not transformed. In addition, from within the farming system, small changes are quickly seen as a transformation, while for the outside world this may not seem to be the case. In general, the system actors are more involved and affected, and probably will perceive changes as more severe. While all assessments and perceptions should be interpreted by researchers along common definitions, interpretation is always relative to context and perspective.

Resilience attributes are elicited through multiple methods; methods are complementary

Across the qualitative methods various approaches have been used to feed attributes into the five generic principles of diversity, openness, tightness of feedbacks, system reserves, and modularity.

ResAT predefined strategies (e.g. 'buffer resources contribute/constrain *robustness*'). This approach has enabled to clarify the potentially contributing or constraining role of certain policy instruments. A limitation is that instruments may have affected other capacities as well. For instance, the availability of buffer resources in the form of higher margins or some spare land gives room to experiment and, potentially, to *adapt* or even *transform* farming practices, as suggested by Dutch arable farmers in the FoPIA-SURE-Farm workshop.

The predefined list of attributes in FoPIA-SURE-Farm covered a broad range of issues, and allowed to compare the perceived level and contribution to different capacities among case studies. A limitation is that attributes relevant for the case studies may have been left out. However, these can be picked up in the inferring of attributes (next point).

Based on interviews, attributes were inferred through abductive reasoning. Many items converge with FOPIA-SURE-Farm. For instance, 'response diversity' converges with 'we are resilient because we are able to employ multiple activities and survive risk'. The inferring of attributes also enabled to obtain additional insights, such as in relation to sensitive topics (stress, feelings of shame, perceived occurrence of diseases in relation to the use of herbicide and pesticides, collaboration difficulties between family members) and the household perspective. With regard to the latter, partners often played a role in discussing (and realizing) transformations – as their non-farm jobs make them realize that transformation happens in other sectors as well. A limitation of the inferring of attributes is the sensitivity to the interpretation of the researcher.

The three approaches complement each other. However, they mostly all focus on *system* attributes while we might need to understand better what system *actors* are *doing*. This is supported by findings pointing at importance of learning, i.e. among farmers, between farmers and value chain actors, between farmers and risk finance institutions, and between farmers and other household members.

16.3 FURTHER WORK

Multiple processes: are they all equally important?

When considering the conclusions from the case studies, the situation of the farm demographics process seems to have a dominant effect on the assessment of the overall situation in the large-scale arable system in Germany, the beef system in France, and the extensive sheep system in Spain. In contrast, while in Poland and Romania the farm demographics situation is near to collapse, the overall system is regarded as still able to grow. Conversely, in the Dutch arable system, there is room for growth in farm demographics. Yet, the overall system is assessed to be near 'end of growth (or collapse)'. What does this indicate about the importance of the four processes (does it make sense to take the average across processes like in Poland, or can we identify bottleneck processes such as farm demographics in the German system)? This will depend on how and whether the bottleneck can be solved, and what that implies for adaptation/transformation. If internal functions and system functions change, a transformation of the farming system takes place.

A further question with regard to the processes is whether we sufficiently covered the breadth of each of the processes. For instance, is the impact of agricultural production on public goods sufficiently addressed? Quite a few systems considered agricultural production to be at the end of growth. This partly considers the impact on public goods, but possibly not entirely.

"People do not know that they are resilient until they have to be it"

Resilience capacities at system level seem relatively low. However, “in times of crisis, everything becomes fluid”. Did we find evidence for this in the past? For instance, Termeer et al., (2019) illustrate that livestock production drastically reorganized after the second world war, albeit with extensive government support (Marshall plan). Specialized systems have high robustness in a constant environment. When challenges increase and are less predictable, diverse systems become more robust (Ashkenazy et al., 2018). Challenges determine the level of robustness required, and also the type of system that has highest robustness.

Have we sufficiently addressed the system level?

In the SURE-Farm framework we define a farming system as follows:

A farming system is characterized by its actors (farms and other actors with mutual influence) and locality. Naming FS by referring to farm type and region, e.g. ‘large-scale arable farming in East Anglia (UK)’, is a short-hand. While the farm type highlights the marketable goods (e.g. arable crops), the region is a short-hand for the related public goods that are mostly bound to landscape and location, and for the farm and non-farm actors, many of which will be located in the region. (Meuwissen et al., 2019).

While we have identified multiple system actors in the eleven case study areas, most respondents were farmers. This may explain why e.g. most future strategies relate to the farm level. Nevertheless, when carefully interpreting the findings of the risk management focus groups, policy analyses, FoPIA-SURE-Farm workshops, and farmers’ answers ample suggestions for the role of beyond-farm system actors can be derived. This needs more attention.

“System change happens everywhere and all the time”; what have we learned?

Farmers quitting their business is not a new phenomenon. However, if too many quit, there may be insufficient critical mass (including diversity and learning opportunities) at system level? A reduced number of farms generally implies larger farms, and hence more capital. In turn, this can mean more lock-in and less capacity to transform. On the other hand, larger farms are better able to align and plan supply with wholesale and retail stages of the value chain. Also, the capital issue can be addressed though involving multiple shareholders/owners and other group structures. Whether there is a limit to farm size and farm numbers remains a question.

Complement qualitative analyses with (more) quantitative analyses

So far, the quantitative assessment relates to the provision of ecosystem services (ES). Comparing ES outcomes and qualitative assessments as summarized on the factsheets shows that the latter are generally less optimistic. This might indicate that policy should not only be based on ‘objective indicators’. Further research will consider other methodologies and other indicators beyond the ES assessment, including indicators’ development over time.

What are the actors doing?

As suggested above, attributes provide insight into system characteristics. However, more insight is needed into the actual behavior and decision making power of all farming system actors. This likely enables to formulate more concrete policy recommendations. While some insights have been obtained from the methods reported, the role of actors has not yet been synthesized.

Too much focus on challenges?

Is it logical that the majority of systems is ‘at the edge of collapse’ or ‘is no longer able to grow’. Did we focus too much on challenges (and too little on opportunities)? In the 2^{nd} workshop series of FoPIA-SURE-Farm, the future of the case study farming systems will be discussed, and more insights will be obtained.

Which resilience capacity is best? Or is there an optimal mix of capacities?

Farm survey results indicate that each of the perceived capacities (robustness, adaptability, transformability) contributes to perceived resilience. Do we have evidence that is also the case at system level? Is there an optimal mix of capacities? We argued that required capacities and future strategies should align with the place in the adaptive cycle. The closer a system is to collapse/reorganization, the higher the need for transformability. When there is still room for growth, robustness is more important. ‘Resilience for what purpose’ is also relevant here: many systems have experienced growth along with good performance of private goods and relatively high robustness. However, a low delivery of public goods affects resilience in the long term, and hence there is a need for adaptability and transformability. To what extent which capacity is required, and when, requires further investigation.

Don’t forget the blooming cases

While at farming system level, findings show relatively low resilience, resilience capacities are more optimistic at farm level. What are the lessons?

What have we learned about panarchy?

For instance, do we see resilience at one level but not at the other? Are there spillovers from one level to the other? The possibilities of cascading scales will be further addressed.

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18 APPENDIX A. ITALY: ECONOMIC PERFORMANCE AND RISK OF FARMING SYSTEMS SPECIALIZED IN PERENNIAL CROPS: AN ANALYSIS OF ITALIAN HAZELNUT PRODUCTION

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Note: This is a summary of a research that has produced the following paper:

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Introduction

The combined assessment of economic performance and risks are key in determining the resilience and sustainability of farming systems (Meuwissen et al., 2018; Reidsma et al., 2015). When farms are specialized in producing perennial crops, risk should be carefully managed by using available risk management strategies and tools. The European Union's (EU) Common Agricultural Policy (CAP) provides three different risk management measures (Bardají and Garrido, 2016).

Assessing overall risk, as well as identifying and quantifying the type of risk facing a farming system is needed to decide risk management strategies and tools because farmers are affected by risks related to production and market (Hardaker et al., 2015). Several methods have been proposed for doing so (Goetz, 1993, Gocsik et al., 2013; Herrmann et al., 2014; Groen et al., 2014) including stochastic simulation that combines information regarding the distribution of different stochastic input variables (Antle, 1983; Castañeda-Vera and Garrido, 2017; Kamali et al., 2017; Lien et al., 2007; Luo et al., 2017; Fariña et al. 2013; Monjardino et al., 2013; Ghasemi et al., 2012).

This study assesses and compares the level and the risk of the profitability of hazelnut in the main areas of production in Italy based on historical farm-level data. Furthermore, it identifies the most important variables affecting the profitability of the crop among yield, product quality and price. The specific objectives of the analysis are: (i) to assess the degree of profitability and risk in the main areas of production; (ii) to test whether profitability and risk differed among areas; (iii) to identify the key parameters making the greatest contribution to the risk involved with farm activities; (iv) and to verify whether there were differences in risk-generating parameters among the four regions.

The results of this analysis can support farmers in deciding whether it is worth changing their risk management strategies; in identifying the most relevant risk sources; and in selecting the most appropriate risk management tools.

The next section describes the study area, data and methods used. Section 3 presents the results of the analysis. Section Discussion and Conclusion closes the paper.

Materials and methods

The key hazelnut production areas in Italy are located almost exclusively within four regions: for the period 2008-2017, Campania and Lazio jointly accounted for approximately two thirds of national production (34% and 33% respectively), with the remaining production located in Piedmont (20%), Sicily (11%), and other regions (2%) (Istat, 2017).

Hazelnut production in these four regions plays a crucial role in the local economy as well as an environmental safeguard (Anania and Aiello, 1999). Average yields levels differ among the four aforementioned regions: they are higher than the national average (1.59 tons/ha) in Lazio and Campania (1.95 and 1.86 tons/ha respectively), lower in Piedmont and even lower in Sicily (Istat, 2017).

The data used in this study was obtained from the Italian Farm Accountancy Data Network (FADN) sample and it refers to the period 2008-2016 (CREA, 2018). An original sample of 1,756 observations (obs.) was extracted and then filtered to eliminate hazelnut in the establishment period (i.e., in the first 6 years after plantation) because there is no production or it is negligible (Frascarelli, 2017). The final sample contains 1,192 observations regarding Piedmont, Lazio, Sicily and Campania (Table 1).

The key variables of interest are crop gross margin (GM), yield, product quality and the standard-quality price of hazelnuts without shells, as well as specific variable costs. All values refer to a single hectare of land to make comparable observations and production areas. Monetary values were deflated using annual coefficients (Istat, 2018) to permit comparability over time.

Profitability is assessed by using the crop gross margins (GM) (€/ha) given by the difference between crop revenues and the specific variable crop costs of farms (Castaneda-Vera and Garrido, 2017; Luo et al., 2017):

$$\mathrm{GM}_{\mathrm{i},t} = R_{\mathrm{i},t} - Cv_{\mathrm{i},t} \quad \text{(A1)}$$

where GM is the unitary gross margin, R are revenues and Cv are specific variable costs associated with the crop in the i-th farm in the t-th year.

Table A1. Sample size by region and year.

Regions	2008	2009	2010	2011	2012	2013	2014	2015	2016	Obs. (2008-2016)
Piedmont	62	73	73	64	68	67	75	72	55	609
Lazio	13	16	29	39	45	52	99	30	40	363
Campania	13	15	23	22	14	15	19	26	28	175
Sicily	3	4	5	6	4	5	7	6	5	45
TOTAL	91	108	130	131	131	139	200	134	128	1,192

Source: Authors' elaborations on Italian FADN data.

The probability density functions (PDFs) of GM, as well as yield, price and quality index, were described by using the four moments of the distribution. The centre of the distribution (μ) was used to compare the profitability among the different areas. Variability was evaluated in absolute (σ) and relative terms, with respect to the mean values (Coefficient of Variation, CV), in observing potential outcomes. Because of the non-symmetric nature of the distributions, the degree of skewness and kurtosis reveal insights regarding the probability of negative results and extreme events respectively.

All farms in each of the four regions were assumed to face the same risk because the available data do not permit a single-farm analysis. However, this assumption seems reasonable because each region is relatively small in surface area and homogeneous regarding climatic and soil characteristics. The risk associated with producing the hazelnut crop was assessed by calculating several risk indexes (Luo et al., 2017; Kandulu et al., 2012; Monjardino et al., 2013). To obtain information on the left side of the distributions, a semi-standard deviation (SSD) and a semi-coefficient of variation (SCV) were also computed and analysed (Mun, 2006; Monjardino et al., 2013). Other risk measures were also used: the break-even point (P[GM]≥0, i.e. the probability of returning a profit), the Value at Risk (VaR) and Expected Tail Loss (ETL). VaR is the maximum loss which may be expected over a given horizon period at a given confidence level (Dowd, 2007):

$$VaR = E(GM) - V^{*} \quad \text{(A2)}$$

where E(GM) is the expected mean of GM and V* is the expected value of GM at a confidence level of 95%. That is, how much of the expected GM could be lost if a tail event (i.e. negative but unlikely) occurs. VaR only states the maximum loss if a tail event (i.e. exceeding 95% c.l.) does not occur. It refers to a chosen probability level (e.g., 95%) but reveals nothing about that which could be lost after that level (i.e. the remaining 5% of cases). However, if a tail event occurs, it can be expected to lose more than the VaR; the VaR figure itself gives no indication of how much that might be (Dowd, 2007). To overcome this drawback, the ETL index was also calculated; this refers to the expected value of losses if extreme events occur. The latter are defined as those in which the losses (L) exceed the VaR (Dowd, 2007):

$$ETL = E[L|L > VaR] \quad \text{(A3)}$$

ETL was calculated using the approach proposed by Dowd (2007). The results of VaR and ETL were also compared with the values of expected GM at 95% c.l. (E[GM]95%) and an average of the expected GMs in the last 5% of c.l. on the left tail of the curve (E[GM]>95%) respectively. VaR and ETL can also be expressed as relative values by using the average GM as a denominator (VaR% and ETL%).

The Monte Carlo (MC) sampling framework (Hardaker et al., 2015) was used to iteratively draw hazelnut yields, prices and quality indicators from the PDF, to model input data and to simulate their impact on GM as in Luo et al. (2017). GM can be seen as:

$$\widetilde{\mathrm{GM}_{\mathrm{i},t}} = \widetilde{R_{\mathrm{i},t}} - Cv_{\mathrm{i}} \quad \text{(A4)}$$

where the tildes identify what is assumed to be a stochastic variable. $\widetilde{R_{i,t}}$ is derived through the product of simulated crop yields ($\tilde{y}$), price of hazelnut without shell ($\tilde{p}$) and a quality index ($\tilde{q}$):

$$\widetilde{R_{i,t}} = \tilde{y}_{i,t} \cdot \tilde{p}_t \cdot \tilde{q}_{i,t} \qquad \text{(A5)}$$

Yields are calculated as the ratio of produced quantity to the cultivated area in each farm (i) every year (t). Dividing the total value of production by the produced quantity, it is possible to identify a proxy of the average received price. This is affected by the development of market price (expressed in terms of standard-quality shelled hazelnuts) and the average quality of the product obtained on the farm. The average annual market prices were obtained from the Chamber of Commerce, Industry, Crafts, and Agriculture (CCICA)[21]. As is standard practice in the literature relating to risk analysis, the price series has been detrended to only assess the spread around the estimated trend in order to refer to uncertain developments in price (Miranda and Glauber, 1997; Lien et al., 2007).

Inter-farm price heterogeneity was used as a proxy for product quality. To account for quality-related aspects, the following quality index was calculated:

$$\tilde{q}_{i,t} = \left(\tilde{P}_{i,t}/\tilde{p}_t\right) \qquad \text{(A6)}$$

where P is the average revenue obtained for each produced quantity of hazelnut in shell. This was obtained as the ratio between total gross production value (TGP) to produced quantity (Q), using FADN data from each farm and for each year:

$$P_{i,t} = (TGP/Q)_{i,t} \qquad \text{(A7)}$$

Crop specific costs (including direct costs, reuses and other costs) were not considered as stochastic.

The stochastic MC simulations, developed using the Version 7.5.2 @RiskTM software (Palisade Corporation, Newfield, New York).

The random components hazelnut yield, price and quality are the key input variables. Combining a very large number of different possible input parameters, 10,000 random iterations were used to define the simulated range of farm business profitability. Correlations between the three key input variables were verified by using Spearman Rank correlation coefficients.

The PDFs for yield, price and quality index were fitted considering a range of suitable PDFs. These distributions were ranked according to the goodness-of-fit tests, which provides a measure of how closely the fitted distribution matched the data distribution. The Akaike Information Criteria (AIC) statistics test was chosen to measure the goodness-of-fit of each input variable in this paper. This criterion defines the best density function from the log-likelihood function, taking into account the

[21] The price series relating to the Viterbo CCICA and Avellino CCICA were used for the Piedmont-Lazio and Campania-Sicily areas respectively, after they had been deflated.

number of parameters of the fitted distribution (Gelman et al, 2014; Burnham and Anderson, 2004; Bozdogan, 1987).

The selected PDFs were used in the MC simulation of GM. Hazelnut prices were found to be logistically distributed, as in the case of wheat by Monjardino et al. (2013), being the PDFs typified by leptocurticity and positive skewness. Different fits were observed for yields and quality index distribution data[22].

In order to verify whether the distributions of the variables under consideration (yield, price, quality index and GM) were significantly different among the regions, the Wilcoxon–Mann–Whitney test was applied given the results of the Shapiro test[23] (Wilcoxon, 1945; Mann and Whitney, 1947; Fay and Proschan, 2010).

A sensitivity analysis was performed to identify those input variables which impact GM outcomes and the degree of this impact. First, a multivariate regression between GM and the key input variables was estimated (Saltelli et al., 2008). Subsequently, following Ghasemi et al. (2012) and Kamali et al. (2017), a multivariate stepwise regression analysis was performed. It consisted of varying the level of one input parameter across the possible range while other input parameters were kept constant at their mean values. This provided a quantification of the effect of each factor on the dependent variable of interest. The dependent variable used in the model was the GM output, and the independent variables were each a random function, defined for each stochastic input variable of the model (i.e. yield, price and quality index).

Since the variables are measured in different units of measurement, a Regression-Mapped Values approach was used. These mapped values are the beta coefficients produced from a regression that uses standardized variables (Kamali, 2017; Ghasemi, 2012). The results of this approach are shown by means of tornado graphs. The length of the bar shows the change in output due to a unitary standard deviation change in the input.

Results

The average unitary GM (€/ha) was used to assess the profitability in hazelnut production. Campania and Lazio were the most profitable regions for hazelnut production with the Piedmont region attaining the third position with the region of Sicily trailing significantly (Table A2).

[22] Additional information and results are available on the published paper.

[23] The results of the Shapiro test permit the rejection of the hypothesis of normality of the distribution in all but one case. Such tests were carried out by using the Rstudio software (Crawley, 2012).

Table A2. Descriptive statistics of the gross margin.

Regions	GM PDF	μ (€/ha)	σ (€/ha)	CV (%)	SSD (€/ha)	SCV (%)	Skewness	Kurtosis
Piedmont	Log-Logistic	4,754	3,009	63	1,787	38	1.54	9.71
Lazio	Log-Logistic	5,032	2,760	55	1,764	35	0.88	6.02
Campania	Pearson5	5,690	3,047	54	1,705	30	1.75	9.23
Sicily	Weibull	2,786	1,816	65	1,108	40	0.94	4.00

Source: Authors' elaborations on Italian FADN data.

Although Campania is the most profitable region (5,690 €/ha), followed by Lazio (5,032 €/ha), the Wilcoxon-Mann-Whitney test revealed that the difference between these two regions is not statistically significant. The low profitability of Sicily is due to the specific structural characteristics of Sicilian farms.

Hazelnut production is quite risky but differences exist between regions: it is higher in Piedmont and Sicily than in the other regions. The GM distributions in the four regions are not symmetric (Fig. A1).

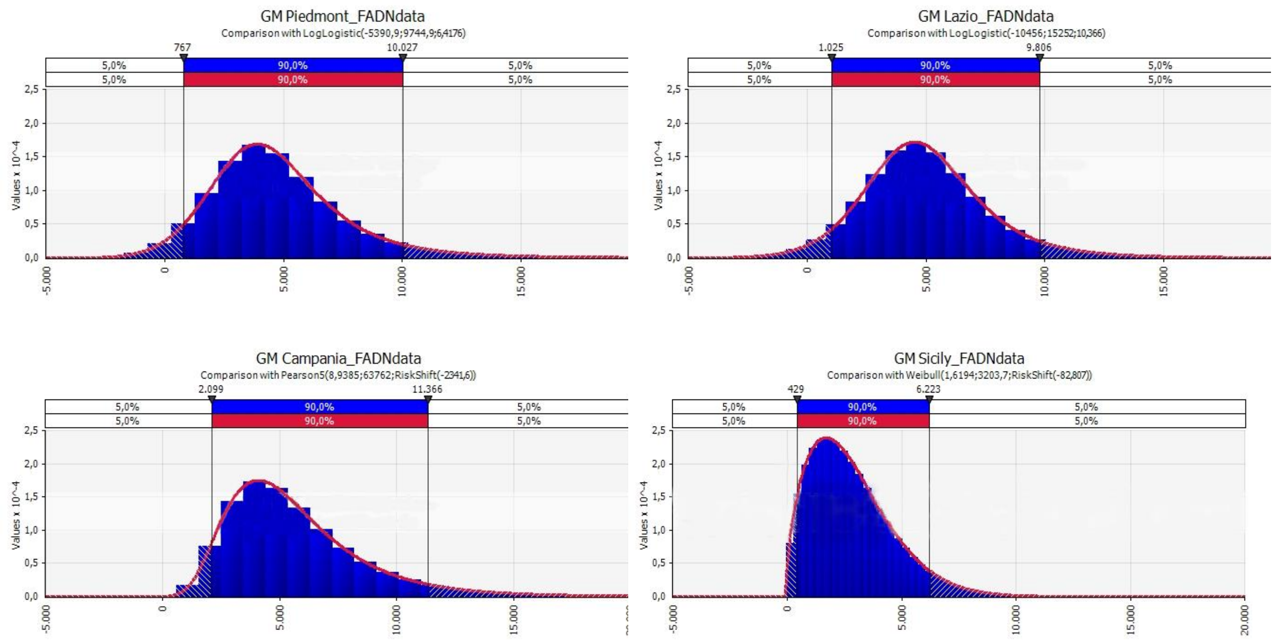

Figure A1. Probability density functions of the unitary GM of hazelnut (€/ha). Source: Authors' elaborations on Italian FADN data (Zinnanti et al., 2019).

Hence it is important to focus on the left-side tails of the distributions (i.e. the worst outcomes). The SSD and the SCV confirm that Campania is exposed to a lower risk than is the case with the other regions.

The PDFs of GM are positive or right-skewed for all four regions and this is particularly the case with Piedmont and Campania. Contemporaneously, a high kurtosis provides information regarding the probabilities of extreme and catastrophic events (potential large losses) and these are relatively higher in Piedmont and Campania. Here skewness values are higher than 1, demonstrating that these regions face a high frequency of low GM levels. Further insights can be obtained by observing the VaR and ETL, both of which are also specifically focused on the left tail of the PDFs. The VaR study was performed by comparing the absolute and relative terms of VaR with the value of the expected GM at a confidence level of 95% (Table A3).

Table A3 - Economic risk measures.

Regions	μ (€/ha)	Value at Risk			Expected Tail Loss			Probability of Break-even
		E[GM] 95%*	VaR (€)	VaR% *	ETL(€)	ETL%*	E[GM] >95%*	P[GM]≥0
Piedmont	4,754	767	3,987	83.86	4,691	98.7	63	97.8%
Lazio	5,032	1,025	4,007	79.64	4,854	96.5	178	98.0%
Campania	5,690	2,099	3,591	63.11	3,981	69.9	171	100.0%
Sicily	2,786	429	2,358	84.61	2,531	90.8	255	99.7%

* E[GM] 95% measures the expected GM at a c.l. of 95%; VaR% is a relative measure of VaR, referring to the mean; E[GM]> 95% measures an average of the expected GMs in the last 5% of c.l. on the left tail of the curve; ETL% is a relative measure of ETL referring to the mean.

Source: Authors' elaborations on Italian FADN data.

Despite the highest absolute values of VaR being recorded in Piedmont and Lazio, VaR% suggested that the highest relative risk was to be located in Sicily and Piedmont. Indeed, the VaR% was lower in Campania where, at the 95% confidence level, farmers could lose 63% of the regional average GM. Even if this were to happen, farmers would still gain € 2,099/ha (E[GM]95%), that is, the highest expected value at that confidence level of the four regions. The VaR% index was also high in Lazio but less than in Piedmont and Sicily. All these results imply that Sicily is the riskiest region for hazelnut production, followed by Piedmont and Lazio, and finally Campania.

The possible economic results which may occur if catastrophic events (i.e. events referring to 5% of the distributions) are analyzed. The absolute and relative values of the ETL were analyzed, as well as the average GM in the 5% of the left-side tail of the function (i.e. the average outcome from the conditions referring to 5% of such cases). The ETL% results suggested that the most limited impact of such events is found in Campania, followed by Sicily with the joint place being held by Lazio and Piedmont.

In cases of the aforementioned negative events, farmers in Campania could still obtain an outcome (E[GM]95%), which is definitely higher than in other regions. Significantly more negative results occur in the other regions. All these results suggest that hazelnut production, especially in Piedmont and Lazio, is affected by high risks and that, under very negative (even if not probable) conditions, the economic results could drop markedly below the level of expected GM. These results also suggest that the four Italian regions differ not only in terms of expected profitability but also in terms of the risk of their activity.

The relative importance of yield, quality and price in generating the overall risk of hazelnut production has been assessed by sensitivity analysis. These results are shown by means of tornado graphs (Fig. 2).

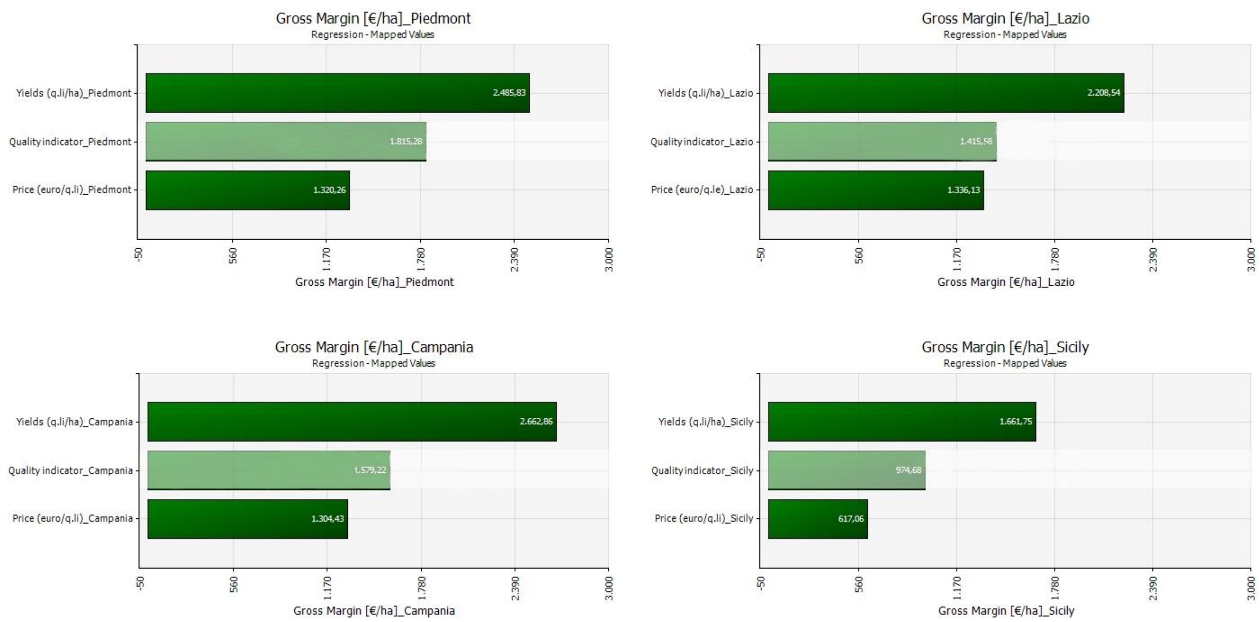

Figure A2 - Tornado graphs showing the results of the Regression-Mapped value analysis. Source: Authors' elaborations on Italian FADN data (Zinnanti et al., 2019).

Yield is the factor generating the greatest GM variability at the farm level in all regions. The second factor is product quality, while the market price has a minimal effect on GM variability. Yields are of greater importance in Campania and Sicily than in the other two regions. Product quality also plays an important role, especially in Piedmont. Finally, the price has a very limited role in determining the GM variability in Piedmont and, even more so, in Sicily. These results highlighted that the regions under consideration also differ in terms of the relative importance of the three considered factors. Hence, farmers in the four regions may wish to make use of different risk management strategies and tools. While crop yield is the key parameter in stabilizing GM, it also seems important to consider how to manage fluctuations in product quality.

Discussion and Conclusion

This study has performed a comparative analysis of the profitability and risk profile of hazelnut production, upon which farmers in the four Italian regions rely heavily. This analysis seems timely, given the growing interest in this crop, which is expanding in terms of area under cultivation. Furthermore, given the perennial nature of the hazelnut crop, its high establishment costs and a production variability in quality and prices, it is important to pay attention to risk management considering the individual components affecting it (i.e., price, yield and product quality).

This analysis has permitted the attaining of specific research objectives: (i) to assess the extent of profitability and risk in the four production areas; (ii) to test whether these two factors differ among regions; (iii) to identify the key parameters making the largest contribution to farming-related risk; (iv) and to verify whether there are differences in risk-producing parameters between the four regions.

The study areas under investigation differ from each other in several aspects. Campania and Lazio have the most profitable hazelnut production on average while Sicily is the least profitable. Unlike the central-northern regions, Sicily suffers from steep-sloped and small fields which make hazelnut cultivation difficult to mechanise.

According to our results, hazelnut production, especially in Piedmont and Lazio, is affected by high risks and that, under very negative (even if not probable) conditions, the economic results could drop markedly below the level of expected GM. However, the gross margin risk in Sicily is relatively high, thereby suggesting the requirement to skillfully manage it. This factor differs among the four regions discussed in this research: cultivation in Campania is less risky than in Sicily, Piedmont and Lazio.

The most important source of risk for all four regions is yield, followed by the product quality and, to a lesser extent, market price for hazelnuts without shell. While this is the general pattern in all four areas, the relative magnitude of these sources of risk differs: for example, product quality in Piedmont plays a not indifferent role in determining the overall risk of this crop.

These results could assist farmers in the decision-making of whether to intensify their risk management strategies and which tool to use. Hazelnut farmers should focus their attention on tools to reduce production risk (e.g., production insurance). Less attention should be paid to managing market risk because price volatility has been found as the least important factor affecting the economic performance of hazelnut production. In contrast, there is scope for developing tools to improve farmers' capacity to cope with risks related to product quality.

The results regarding the expected profitability and risk of the activity could be important to agents who are interested in expanding hazelnut cultivation. Such information could greatly assist investment analyses by developing, for example, net present value analyses accounting for the uncertain nature of economic results.

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19 APPENDIX B. ITALY: POTENTIAL IMPACTS AND FINANCIAL SUSTAINABILITY OF THE INCOME STABILIZATION TOOL

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Keywords: Income stabilization; Risk management; Insurance pricing; Gross margin; expected utility.

Abstract

Income risk is pervasive in all farming systems, although there are differences among farms by sector. Farmers can use several instruments to cope with income risks. The Income Stabilization Tool (IST), introduced in the European Union (EU), is based on a public-private partnership and is managed by a Mutual Fund (MF) steered by associated farmers. These latter pay an annual contribution to become eligible for receiving indemnities when experiencing a severe income drop.

This study assesses the impact of the IST on the level and riskiness of farm income. It also evaluates the feasibility of this tool to make supply and demand interact. Finally, the study assesses the geographical scale at which the IST scheme could be implemented.

This is done on hazelnut farms located in the four main production areas of Italy by using data from the Farm Accountancy Data Network in the period 2008–2017. The potential impact of the IST on farm income was assessed through a profitability and riskiness analysis. Subsequently, stochastic dominance and expected utility analyses were performed to evaluate the farmers' willingness to use this tool. Finally, the financial sustainability of the MF was assessed according to actuarial principles and accounting for loading costs and the public support.

The results of the analysis show that the IST reduces strongly the riskiness of the income of hazelnut farmers in all Italian production regions. Moreover, supply can interact with farmers' demand, making a sectorial IST potentially feasible also because the presence of public support. Lastly, farmers' contribution should be differentiated among regions, while it is advisable to take advantage of the risk-pooling principle by opting for a nationwide MF. This study provides insights that could support stakeholders in deciding whether to implement IST in specialized farming systems and recommendations on how to design its scheme in an efficient way. This seems important, given that this new tool has not been yet implemented in the EU.

Introduction

The resilience and sustainability of farms are influenced strongly by their capacity to survive various risks and shocks that affect their income (Lien et al., 2007; Meuwissen et al., 2018; Reidsma et al., 2015). For example, in the European Union (EU), a relatively large amount of farmers face severe income drops: every year during the period 1998–2006, approximately a quarter of farms in the EU incurred in severe losses (i.e. income drops greater than 30% of their average income) each year

(European Commission, 2009). The relative share of these farms changes by sector and by economic size class. For example, because of the high variation of both pig and poultry prices, "granivore" farms experienced the greatest income variability, whereas the dairy sector showed rather limited variability. Similarly, small farms are more exposed to large (relative) income variability than are big farms (European Commission, 2009). According to Trestini et al. (2017), farms that specialize in horticulture and in permanent crops (other than viticulture) have a relatively high probability of severe losses.

Risk management may ensure that a farm remains in or returns swiftly to the *status quo* when facing potentially disruptive challenges (Meuwissen et al., 2019). A stable flow of income is a prerequisite for allowing farms to also adapt and transform in response to evolving conditions. In particular, higher uncertainty reduces the responsiveness of investment to demand shocks, making firms more cautious when either investing or disinvesting [see, for example, Bloom et al., (2007)].

Farmers can use several instruments to cope with risks (Bielza Diaz-Caneja et al., 2008; Meuwissen et al., 2013). However, there is an interesting and innovative way to do so. Whole-farm income insurance schemes have attracted the interest of agricultural policy-makers world-wide, and the EU Rural Development Policy (RDP) has introduced the Income Stabilization Tool (IST) [Article 39 of Regulation (EU) No 1305/2013]. The IST is based on a public–private partnership that provides compensation (i.e., indemnities) to farmers who experience a severe income drop (Bardaji and Garrido, 2016). The IST is managed by a Mutual Fund (MF) steered by associated farmers who pay an annual contribution to the MF to become eligible for receiving indemnities when their incomes either decrease by over 30% from the expected income or, in the case of sector-specific IST, decrease by over 20% their average historical level [Regulation (EU) No 2017/2393]. After the first three years of the setting-up of the MF, the financial contributions provided by the RDP cover the amounts paid by the MF as indemnification to farmers. These indemnifications may also relate to interests on commercial loans taken out for the purpose of compensate farmers in case of crisis. The public support is expected to foster the development of MF and farmers' participation to the IST (Cordier and Santeramo, 2019).The IST has several desirable features. First, it refers to the farm income as a whole and considers the complex nature of farm risk (i.e., not just production risk like farm insurance) as weel as the correlation between prices and yields and across the profits from different farm activities (Meuwissen et al., 2003; Severini et al., 2016). Second, the IST has the potential to cover also systemic risks (specifically price risk) that are not covered by purely commercial insurances hampering the principles of risk pooling (Meuwissen et al., 2003). Third, it moves away from a mainstream market-based approach (e.g., insurances) because, in contrast with traditional insurance products that are offered by insurance companies, it is based on MFs managed by groups of farmers (Cordier and Santeramo, 2019). Fourth, it can be supported by agricultural policies being in agreement with World Trade Organization green-box requirements (e.g., Mary et al., 2013).

This paper investigates the potential implications of introducing a sector specific IST considering the case of hazelnut producers located in the four main production areas of Italy as a case study. Italy is the second-largest producer of hazelnuts in the world (14.3%) after Turkey (CREA, 2018; FAOstat, 2018). Moreover, Italy plays a central role in the international market, being one of the main buyers in the international market for hazelnuts and one of the main exporters of processed products (Liso et al., 2017).

The IST could reduce income risk, increase farmers' wellbeing, and reduce the risk of default. This is relevant in the hazelnut sector as it is fast developing in response to an ever growing demand for products derived from hazelnuts (Cristofori et al., 2008; Cristofori et al., 2015; Liso et al., 2017, Dobhal et al., 2018). This is pushing toward a high level of production specialization and, in turn, a high level of income risk (Zinnanti et al., 2019). The level of risk faced by hazelnut farmers in Italy has been assessed by Zinnanti et al. (2019). However, no previous analyses have explored ways to manage risks and demonstrate their potential impact. In contrast, supporting hazelnut farmers in managing income risk is particularly important because they rely on a perennial crop, where changing production patterns is constrained strongly by high costs and lengthy implementation time.

The role of IST has been seen by some authors as potentially very positive, whereas others have suggested that there are many issues to address before making it applicable (see Cordier and Santeramo, 2019, for a recent review). There is now a large amount of research on the effects of IST. For example, Finger and El Benni (2014a) and El Benni et al. (2016) found that this tool stabilizes farm-incomes, but it increases the income inequality within the farm population, because the benefits from such a tool might be highly heterogeneous across farm types. Other studies have focused on actuarial evaluations of potential income insurance, its governmental costs, potential beneficiaries within the farm population, and conceptual investigation of problems of adverse selection and moral hazard with such whole-farm income insurance tools (Dell'Aquila and Cimino, 2012; Liesivaara et al., 2012; Liesivaara and Myyrä, 2016; Pigeon et al., 2014; Mary et al., 2013; El Benni et al. 2016; Finger and El Benni, 2014a and 2014b). This paper adds to the literature, because very few analyses have assessed the potential impact of the IST when applied at a sectorial level (Trestini et al., 2018), and none have addressed the hazelnut sector specifically. More importantly, the mandatory participation commonly assumed by previous analyses was not considered in this study (El Benni et al., 2016; European Commission, 2009; Finger and El Benni, 2014a; 2014b; Severini et al., 2018). Furthermore, the current analysis also explores the feasibility of the system by assessing whether there is scope for developing IST (i.e., supply and demand interact) under plausible hypotheses regarding the levels of contribution to the MF, policy support, and farmers' risk aversion.

In particular, the paper answers the following three research questions. First, what could be the impact of the IST on the level of income-related risks at farm levels? Second, is the IST feasible, given that there is scope for supply and demand to interact? In answer this crucial question, the maximum level of contribution to which farmers are willing to participate in the IST and the minimum contribution that makes the MF managing the IST financially viable were both assessed. Third, which geographical scale should be adopted when implementing IST (i.e., either national or regional)?

The results of the analysis provide insights that can support stakeholders in deciding whether to implement this innovative tool and how to design it. This seems important given that this tool has not been yet implemented throughout the EU (Severini et al., 2018; Trestini et al., 2017 and 2018). Hence there is scope to assess whether the introduction of the IST will be successful in specific regions and types of farming, to decide the level of contribution the MF should charge participating farms. Furthermore, this kind of analyses could provide two types of policy recommendations: (1) the advisability of managing IST at national or regional level and (2) the financial risk of fluctuations in the overall amount of payments paid by the MF to farmers over the years.

The paper is organized as follows. Section 2 describes the data and the methods used in this analysis, including a description of the functioning of the IST. Section 3 presents the results of the analysis regarding the potential impact of the IST on level and riskiness of farm income, the feasibility of the IST, and the appropriate geographical scale on which design the IST. Section 4 closes the paper, providing a discussion of the results.

Material and method

Italian hazelnut production is highly geographically concentrated and specialized (Piacentini et al., 2015). Most of the hazelnut production in Italy comes from four regions: Campania, Lazio, Piedmont, and Sicily, accounting for approximately 34%, 33%, 20% ,and 11% of the national production areas in the period 2008–2017 (Istat, 2018). Because of this, this analysis focuses on hazelnut production in these four regions. Data used in this study were obtained from the Italian Farm Accountancy Data Network (FADN) referring to the period 2008-2017[24].

The preliminary sample consisted of 1,973 observations of the crop unitary gross margin (GM) (€ per hectare, €/ha). This is a commonly used activity-based indicator of economic performances of crops given by the difference between crop revenues and crop-specific explicit costs for purchased inputs (such as fertilizers, crop protection products, other specific crop costs excluding overheads and labor cost) (European Commission, 2018; Castañeda-Vera and Garrido, 2017).

Data have subsequently been filtered taking into consideration three aspects. First, observations referring to a utilized agricultural area under hazelnut production lower than 1 ha have been deleted to avoid the inclusion of non-commercial hazelnut production. Second, only observations referring to plantations older than 7 years were included, because there is either no or negligible production in this period, which can be considered as being the crop establishment period. Third, farms with a number of observations of fewer than three years within the considered period have been eliminated, because these observations were considered too limited to provide a reliable representation of inter-year variability of economic results. The resulting sample consists of 1,207 observations distributed among regions and years (Table B1).

[24] We wish to thank the CREA-PB of Rome for letting us use the individual farm data.

Table B1. Farm sample (number of observations).

Year	Campania	Lazio	Piedmont	Sicily	Total
2008	13	10	63	4	90
2009	15	11	81	4	111
2010	20	18	82	4	124
2011	19	30	82	5	136
2012	13	29	84	4	130
2013	14	31	81	5	131
2014	17	24	86	5	132
2015	20	23	84	5	132
2016	17	22	82	5	126
2017	14	22	54	5	95
Total	162	220	779	46	1,207

Source: Own elaboration on Italian FADN data.

The analysis assumes farm deflated unitary GM (€/ha) as the income indicator used to apply the IST[25]. This choice is close to that in Trestini et al. (2018), who use the farm Value Added. These indicators have the desirable property of allowing comparison of farms with different levels of involvement of family labor. Furthermore, this choice is in line with the decisions of the Italian Ministry of Agriculture (ISMEA, 2015; Mipaaf, 2017).

Following the Regulation (EU) No 1305/2013, later modified by the Regulation (EU) No 2017/2393, the IST is going to be managed by an MF. In the case of the sectorial IST, farmers are indemnified if their income drops by more than 20% of the expected income level.

Several approaches could be used to identify the expected income. Two of these were foreseen by the EU Regulation in the case of the IST: these are either the average of the three previous years or the Olympic average of the previous 5 years (i.e., the average over the period excluding the lowest and highest levels) (see Finger and El Benni, 2014b for discussions). In this study, because there are not long enough series and because the need to discriminate between the regions studied as they are affected by different risk profile (Zinnanti et al., 2019), we therefore estimate the expected income as an average of the whole period considered (2008–2017)[26].

Given these assumptions, for each individual farm hypothetically participating in the IST scheme:

$x_{i,t}$ is the deflated value of the unitary GM of the i_{th} farm at the t_{th} year; and

$\bar{x}_i$ is the average of the $x_{i,t}$ realized in the period considered (2008–2017) in the i_{th} farm.

[25] EU regulations do not provide specific indications regarding whether the income distributions should be deflated or not. This is probably going to be defined by future implementation rules. The choice of using deflated series seems coherent with the standard practice used within the risk analysis literature (e.g. Hardaker et al., 2015).

[26] Considering the previous three-year period only, might yields different results. Hence, when additional data will be available, it will be interesting to assess how much this choice affects the result of the analysis.

To allow better comparability of the variability of economic results among farms, GM has been standardized by dividing each GM observation by the farm-specific mean of GM. In this way, each regional GM distribution is centered to unity. Formally:

$xs_{i,t}$ is the standardized value of the unitary GM of the i_{th} farm at the t_{th} year, obtained as $xs_{i,t} = \frac{x_{i,t}}{\bar{x}_i}$.

The relative reference income that triggers the indemnification in the t_{th} year is a and it is fixed at 80% by assuming that the minimum trigger allowed by the EU Reg. (EU) no. 2017/2393 is used (i.e. 20%). This simply means that farmers experiencing a drop of GM less than 20% of their average GM are not going to receive any indemnification. Furthermore, farmers who experience a severe drop in income will receive a compensation equal to only a share of the occurred loss. Formally, the indemnification the MF pays to the i_{th} farm in the t_{th} year is:

$$y_{i,t} = \begin{pmatrix} 0 & \text{if } xs_{i,t} \geq a \\ (\bar{x}_i - x_{i,t}) \cdot b & \text{if } xs_{i,t} < a \end{pmatrix} \quad \text{(B1)}$$

where the parameter b is set at 0.7 that is the maximum relative level of indemnification of the losses allowed by the EU Regulation. This partial compensation is supposed to reduce the effects of moral hazard in the case of the IST. In other words, because they will be only partially compensated, farmers are expected not to change their behavior in the case they subscribe an IST. To participate in the IST scheme, farmers must pay an annual contribution to the MF managing the IST that is conceptually similar to the premium paid in the case of the insurances. This analysis assumes that farmers pay contributions that are proportional to their expected income[27] (Severini et al., 2018). Hence, large farms pay larger absolute contributions than small farms.

After having been deflated and standardized, the observed distributions of GM (now called "baseline") have been analyzed and compared with those derived from the application of the IST. However, because the contribution rates have not been defined yet, the following three scenarios of application of the IST have been considered: no contribution ($IST_{0\%}$); contribution rate at 5% ($IST_{5\%}$); and contribution rate at 10% ($IST_{10\%}$). The first scenario is a hypothetical scenario, because it is assumed that farmers do not pay any contribution to the MF. This scenario is used as a benchmark to assess the impact of the contribution rate. The other two scenarios refer to situations in which farmers pay contributions that are set, respectively, at 5% and 10% of the farm GM mean.

Because each region is relatively small in surface area and homogeneous regarding climatic and soil characteristics, it is assumed that all farms in a region face the same relative income risk. This means that the farms within a region face the same distribution of the standardized GM ($xs_{i,t}$). However, we retain the idea that, as observed in reality, the absolute average GM levels differ among farmers

[27] The application of a flat per-farm contribution could change the results of the analysis. However, given the large heterogeneity of farms about size, the use of a flat contribution seems very unlikely in practice.

also within the same region. This allows accounting for the existence of farm-specific individual effects that explain such absolute differences in average values.

Assessing the potential impacts of the IST

The potential impact of introducing the IST was assessed, considering the average profitability and the income-related risk. The analysis assumes that farmers in each region face the same distribution of standardized incomes.[28] The level of profitability of hazelnut production was analyzed by considering the first moment of the distributions (μ) of GM both without and with the IST in place. Apart from the data for each region, the average, weighted according to the area cultivated with hazelnut of each region, is provided.

To assess the riskiness of the activity, the distributions of the standardized GM both without and with the IST have been estimated for each region. From discrete distributions of data, the probability distribution functions (PDFs) by region were estimated by using the *BestFit* tool provided by Version 7.6 of the @Risk™ software (Palisade Corporation, Newfield, New York). The estimations were developed by comparing the goodness-of-fit of each distribution to several functions: the Akaike Information Criterion statistics test was chosen to rank the PDFs. This test provides a measure of how closely the fitted distribution matches the data distribution, defining the best density function from the log-likelihood function and taking into account the number of parameters of the fitted distribution. The risk analysis, by studying the Value at Risk (VaR), was calculated based on the estimated PDF of the unitary GM. According to Dowd (2007), VaR is the maximum loss that may be expected over a given horizon period at a given confidence level. It was calculated as follows:

$$VaR = \bar{x}_i - V^* \qquad (B2)$$

where $\bar{x}_i$ is the average GM and V^* is the value of GM at a confidence level of 95%. This indicator is calculated using the standardized GM and then converted in absolute values. Large values of VaR suggest high risk because this index focuses on the worst outcomes only. Any risk-reducing strategy reduces the level of VaR so that the effectiveness of different risk management strategies can be analyzed through assessing by how much they reduce the VaR they generate. Because the average level of GM differs between the regions considered, the relative VaR (Var%) is reported also: this is given by the ratio between VaR and the average GM. This index facilitates comparison of the riskiness of the activity in the regions considered, indicating how much below the average it is possible to lose in relative terms.

[28] The lack of long enough individual farm income series does not permit to explore farm heterogeneity within the region but only differences between regions. Future research could explore further this issue by considering farm heterogeneity also within each region.

Comparing farmers' wellbeing with and without IST

The likely impact of introducing the IST on farmers' wellbeing has been assessed assuming that farmers are rational, that all agents have full information[29] and ruling-out moral hazard (Hardaker et al., 2015). This latter assumption may not be verified – resulting in higher indemnifications to farmers- because insured farmers could undertake riskier activities than not-insured farmers could (see for example Horowitz and Lichtenberg (1993) for an empirical assessment of the effect of insurance subscription on farmers behavior). However, in the considered case, the extent of moral hazard should not be large because of two main reasons. First, farmers receive indemnities that only partially compensate for the faced losses (i.e. a maximum of 70% of the losses). Second, the perennial nature of the crop and the high specialization of the considered farms reduces the chance of changes in production practices (e.g. pest control).

The likely impact of introducing the IST has been first analyzed using the stochastic dominance (SD) theory that is applied widely to compare risky alternatives (Hardaker et al., 2015). SD is a form of non-parametric stochastic ordering that enables ranking one probability distribution of outcomes as being superior to another distribution (Mishra et al., 2019). Being a criterion of decision rule that provides a partial ordering of risky alternatives, this approach has the desirable property that it does not require normally distributed outcomes (Hardaker et al., 2004; Hildebrandt and Knoke, 2011). Based on Hardaker et al. (2004), the risky alternatives to be compared were assumed to have uncertain outcomes. In this study, values of GM are assumed to be stochastic, and the risky alternatives correspond to non-participation in the IST (i.e., baseline) and participation in the IST considering increasing contribution rates (e.g., $IST_{0\%}$, $IST_{5\%}$, and $IST_{10\%}$).

More in general, given $f_1(w), f_2(w),\ldots, f_n(w)$ the PDF describing the outcomes for n risky alternatives, the corresponding cumulative distribution functions (CDF), denoted by $F_1(w), F_2(w),\ldots, F_n(w)$, were used to define the SD. As explained by Levy (1998), different methods of SD do exist, including first-degree stochastic dominance (FSD) and second-degree stochastic dominance (SSD). FSD occurs when it is possible to order alternatives for decision-makers who prefer more money rather than less money, no matter how risk-averse they are. By graphically comparing the CDFs of two risky alternatives it is generally possible to state that one dominates the other, in the sense of the FSD, if the CDF of the first considered alternative (i.e. $F_A(x)$) is either equal to or less than the second one [i.e. $F_B(x)$] for every possible outcome (Hildebrandt and Knoke, 2011, Hardaker et al., 2015):

$$F_A(x) \leq F_B(x), \text{ for all } x \quad \text{(B3)}$$

Ordering alternatives in this manner allows differentiation among efficient (undominated) and inefficient (dominated) choices (Hildebrandt and Knoke, 2011).

[29] Further developments could relax such assumptions and take stake of the literature based on the prospect theory (Kahneman and Tversky, 1979).

Nevertheless, in some cases, the CDFs of two risky alternatives intersect, making it not possible to rank alternatives by means of the FSD principle. In this case, it is desirable to use SSD, which requires an assumption: decision-makers must be risk-averse for all values of x. This means he/she must have a utility function with decreasing slope (i.e., $U'(x) > 0$ and $U''(x) < 0$) (Hardaker et al., 2015).

The SSD principle states that alternative A is preferred to alternative B for a risk-averse agent if the cumulative area under the CDF for the dominant alternative [i.e. $F_A(x)$] lies everywhere below and to the right of the corresponding curve for the dominated alternative [i.e. $F_B(x)$] (Hardaker et al., 2015). More formally:

$$\int_{-\infty}^{x^*} F_A(x)dx \leq \int_{-\infty}^{x^*} F_B(x)dx \quad for\ all\ values\ of\ x^* \tag{B4}$$

Sometimes, the SSD also does not allow discrimination between risky alternatives. Under these conditions, the result depends strongly on the level of risk aversion of the agent considered. Indeed, for a very risk-averse person, the less risky alternative may be still be preferred even if the SSD principle fails to identify whether one alternative dominates the other. In fact, such a risk-averse agent weighs negative outcomes more heavily than positive outcomes. This may clearly be the case in our empirical analysis, especially when the contribution rate is relatively high.

Because of these considerations, it is more convenient to compare risky alternatives using the expected utility (*E(U)*) approach (Hildebrandt and Knoke, 2011). This approach is based on the assumption that agent behavior is based on the maximization of the expected utility deriving from the stochastic outcomes. Following Masten and Saussier (2002), it is possible to formalize the farmer's decision to either accept or reject the IST scheme (y^*) as a discrete decision-making problem:

$$y^* = \begin{cases} y = 0 & if\ \ U(V^0) \geq U(V^1) \\ y = 1 & if\ \ U(V^0) < U(V^1) \end{cases} \tag{B5}$$

where, in this study, V^o and V^1 represent the net benefits associated with not participating and participating in the IST scheme, respectively.

To implement this approach in practice, it is required, first, to assume a specific functional form for the utility function and, second, to set reference levels of risk aversion. Despite this imposes some restrictions on farmers' behavior, empirical analyses often use the negative exponential form (Hardaker et al., 2015):

$$U = 1 - exp(-cw)\,, c > 0 \tag{B6}$$

where w are the levels of the economic variable of interest that, in this application, is the hazelnut GM, and c denotes the measure of risk aversion that is constant and has the following specification:

$$r_a(w) = -U^{''}(w)/U^{'}(w) \tag{B7}$$

where $U''(w)$ and $U'(w)$ represent the second and first derivatives of the utility functions, respectively (Hardaker et al., 2015). This functional form assumes a constant absolute risk aversion function (CARA).

Love and Buccola (1991), using CARA, revealed that production decisions are affected significantly by revenue uncertainty and/or output price for risk-averse producers. As assumed by Iyer et al. (2019), it is reasonable to assume that farmers are risk-averse, although risk aversion is necessarily a relative concept. In this analysis, three absolute risk aversion coefficients ($r_a(w)$) have been chosen to identify possible alternative risk aversion levels:

- 0.01 risk neutral;
- 0.3 low risk aversion;
- 0.6 high risk aversion.

The choice of these values of risk aversion coefficients is arbitrary and further analyses based on experimental studies may provide context specific insights to refine further the analysis. However, the chosen intervals are supported by other scholars who investigated farmers' risk attitudes in Europe (Cerroni, 2019; Kumbhakar and Tveterås, 2003; Groom et al., 2008; Serra et al., 2008; Piet and Bougherara, 2016; Castaneda-Vera and Garrido, 2017; Iyer et al., 2019).

Participation in the IST depends critically on the level of the contribution requested by the MF. The willingness of farmers to participate in the IST was calculated as the maximum contribution rate (MaxCont) that makes farmers indifferent about whether to participate in the scheme. In particular, the willingness to participate in the IST is the contribution (in %) that makes the farmers' expected utility (adhering to the IST) equal to that obtained in the baseline conditions: $E(U)_{BL} = E(U)_{IST}$.

Assessing the financial sustainability of the MF

On the supply side, it is important to assess which contribution rate will make the IST scheme sustainable from the point of view of the MF managing the scheme. The basics of insurance pricing refer to a fair insurance premium (Bowers et al., 1989). From an insurer point of view, the premium should be such that expected losses (E(X)) do not exceed collected premiums. While various premium principles can be derived (see Embrechts, 1996, for a review), the simplest and most widely used is the expectation principle:

$$\Theta = E(X) + \delta E(X) \tag{B8}$$

Where Θ refers to collected premiums, and δ should be positive and large enough to have sufficiently protective solvency margins that can be derived from ruin estimates of the underlying risk process (Embrechts, 1996). In the field of the insurances, one often considers the loss ratio index: this is the ratio between losses and collected premium. In the case of IST, this is the ratio between paid indemnities and the collected contributions.

The basic consideration that drives insurance pricing is that the price (i.e., the contribution rate in the case of IST) should be both high enough to bring forth sellers and low enough to induce buyers to enroll (Finn and Lane, 1997). Despite this, the literature on insurances and actuarial science generally assumes the number of insured as being constant regardless of the premium charged, a limitation that is very often caused by a lack of factual data on insured behavior. In this paper, it has been considered that MF will also face loading costs and that the Rural Development Policy will cover a share of the costs faced. Based on the average loss ratio experienced in the period 2010–2015 by the subsidized farm insurance schemes in Italy (Ismea, 2018), a benchmark loss ratio of 0.65 is assumed. The level is assumed to be lower than one because MFs are expecting administrative and other loading costs and to have a margin to constitute a fund to be used in the years in which the volume of indemnity is large because of unfavorable economic farm results. Hence, a loss ratio higher than 0.65 may indicate a negative result for the MF because not all costs are covered by farmers' contributions.

Furthermore, it has been assumed that the public support is set on 70% of the costs faced, as stated by the Regulation (EU) 2017/2393. Because it is still not very clear which costs are the basis for establishing the extent of such support, two scenarios have been considered. The first one assumes that public support is calculated over all costs: this results in charging farmers for 30% of the whole costs. The second assumes public support calculated on indemnities costs only: this results in charging farmers for 54% of the whole costs.

Results

The average GM value of the baseline is 4,800 €/ha, but values differ considerably at regional level, varying from 2,569 €/ha (Sicily) to 5,876 €/ha (Campania). The introduction of the IST would greatly increase the average GM values in the hypothetical case that farmers did not have to pay contributions (scenario $IST_{0\%}$) (Table B2).

Table B2. Average GM levels by region (€/ha). Baseline conditions (i.e. no IST) and simulated implementation of the IST.

	Baseline	IST with contribution rates set at:		
		0%	5%	10%
Piedmont	4,999	5,600	5,350	5,100
Campania	5,876	6,176	5,883	5,589
Lazio	5,012	5,435	5,184	4,934
Sicily	2,569	2,843	2,715	2,586
Weighted average	4,800	5,214	4,974	4,734

Source: Own elaboration on Italian FADN data.

Clearly, these levels fall as the contribution rate increases (Table 2). The average GM of $IST_{5\%}$ is still favorable in the four regions, although to a lesser extent for Campania and Lazio, in comparison with the baseline conditions. Lastly, the implementation of a 10% contribution rate ($IST_{10\%}$) allows farmers to reach an average GM that is similar to that of the baseline, even if it drops below this level in

Campania and Lazio (Table 2). Hence, the IST could enhance farm GM unless contributions rates are set at approximately 10% or more.

To assess the impact of the IST on the riskiness of farm income, results of the $VaR_{\%}$ and the $GM^{5\%}$ were observed. $GM^{5\%}$ is the GM level that marks the 95th percentile: at this point, there is a 5% probability of obtaining a value below this GM level. As expected, the riskiness of the activity drops strongly when the IST is implemented: indeed, $VaR_{\%}$ decreases radically moving from the baseline to the implementation of the IST regardless of the contribution rate level, because of the positive role of the indemnifications it provides to farmers experiencing relevant drops in their GM (Table B3).

Table B3. Risk indicators by region in the baseline and with the IST (€/ha and %).

	Baseline		IST with contribution rates at:					
			0%		5%		10%	
	$GM^{5\%}$	$VaR_{\%}$	$GM^{5\%}$	$VaR_{\%}$	$GM^{5\%}$	$VaR_{\%}$	$GM^{5\%}$	$VaR_{\%}$
Piedmont	1,140	77%	3,840	31%	3,590	33%	3,340	35%
Campania	3,279	44%	4,895	21%	4,601	22%	4,307	23%
Lazio	2,100	58%	4,040	26%	3,789	27%	3,538	28%
Sicily	504	80%	1,950	31%	1,822	33%	1,693	35%

Source: Own elaboration on Italian FADN data.

Risk increases as the contribution payment increases (from $IST_{0\%}$ to $IST_{10\%}$). Both options (with and without IST), the Campania and Lazio regions may lose less than the other regions do in relative terms.

The impact of IST is appreciated when shown graphically: the left tail of the Cumulative Distribution Functions of GM in each region is shifted totally to the right (Fig. 1).

The results suggest that the IST could greatly reduce the risk faced by farmers but, in the case of limited contribution rates, it also supports the average farmers' income levels.

3.2. Farmers' willingness to participate in the IST

Following the SD approach, in all four regions, the scenario $IST_{0\%}$ clearly dominates the baseline conditions, suggesting that farmers would be willing to participate under this favorable but implausible condition. The CDFs referring to the scenario $IST_{0\%}$ never lie above that of the baseline: this shows that this scenario dominates the baseline according to the FSD principle and, because of this, it represents an improvement in comparison with the current situation without IST (Figure B1). However, as farmers are charged a contribution, it is not possible to easily assess visually that the IST dominates even according to the SSD principle. Using the *E(U)* approach, it is possible to identify the maximum contribution rate (MaxCont) at which farmers are willing to participate in the IST (i.e., $E(U)_{BL} = E(U)_{IST}$) (Table B4).

Table B4. Contribution rates making farmers indifferent to participating in the IST under three different hypotheses of risk aversion (MaxCont) (%). Source: Own elaboration on Italian FADN data.

	Risk neutral	Low risk-averse	High risk-averse
Campania	5.5%	7.5%	9.5%
Lazio	8.5%	12.5%	17.5%
Piedmont	10.5%	19.5%	25.5%
Sicily	9.5%	13.5%	18.5%
Weighted average	8.3%	13.0%	17.4%

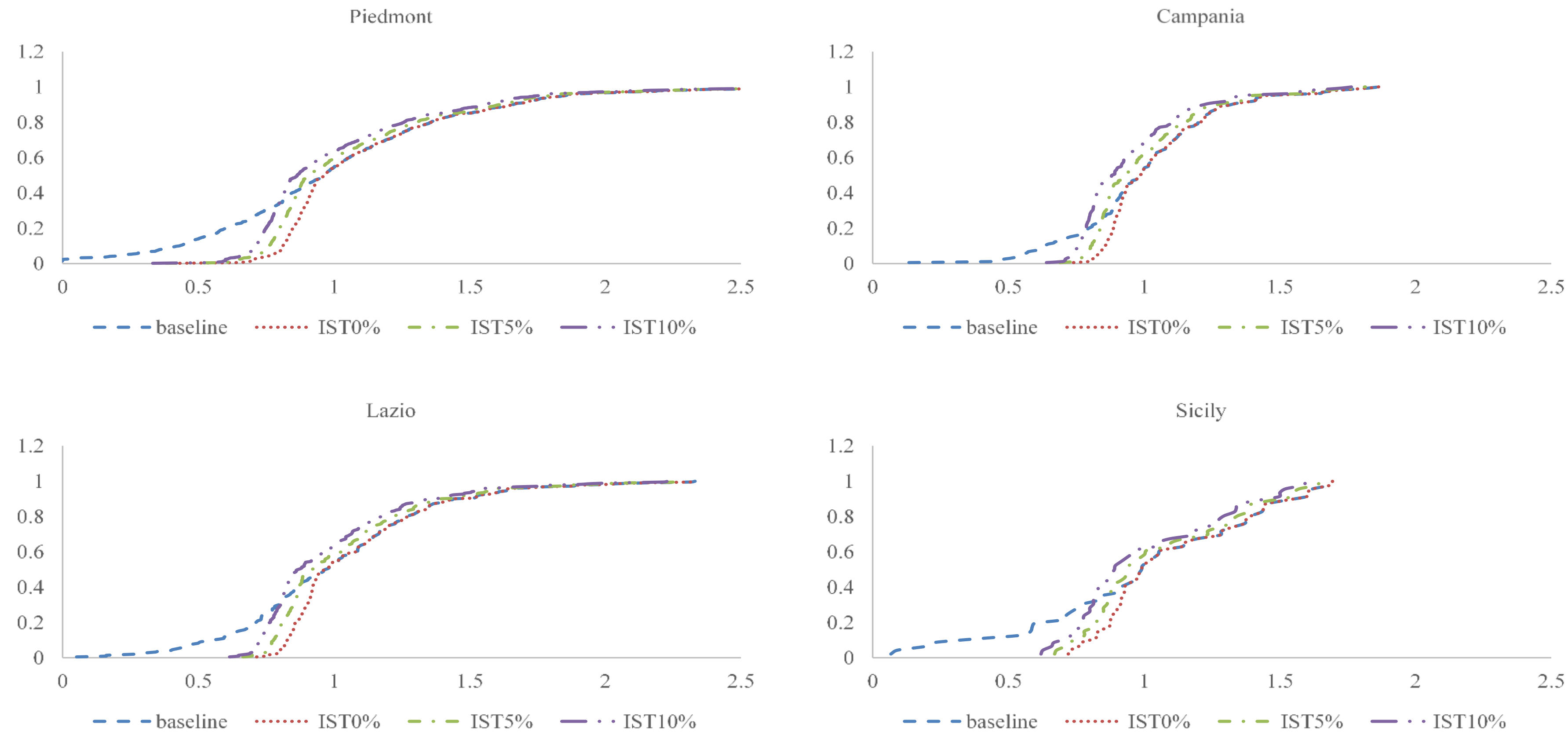

Figure B1 - Cumulative Distribution Functions (CDFs) of standardized GMs in the four regions. Baseline and implementation of the IST with contribution rates at: 0%, 5%, and 10%. Source: Own elaboration on Italian FADN data.

As foreseen, the MaxCont increases as risk aversion increases. The average rate moves from 8.3%, when farmers are assumed to be risk-neutral, but it increases up to 17.4% assuming a high level of risk aversion. These results suggest that, under the conditions considered, there is a relatively high willingness to participate in the IST, even for moderate levels of risk aversion.

However, the level of willingness to participate in the IST, expressed in terms of MaxCont, differs among regions: in Piedmont and Campania farmers are willing to participate with higher and lower rates, respectively, than are farmers in other regions. The farmers in Lazio and Sicily are in between.

Contribution rates making the MF economically sustainable

From the MF point of view, the minimum contribution rates required to make management of the IST financially sustainable are shown in Table B5.

Table B5. Minimum contribution rate required by the MF (%) to make the scheme economically sustainable both without and with public support. Source: Own elaboration on Italian FADN data.

	no public support	with public support	
		on indemnities costs only (0.54)	*on all costs (0.30)*
Campania	7.5%	4.1%	2.3%
Lazio	12.5%	6.8%	3.8%
Piedmont	16.5%	8.9%	5.0%
Sicily	14.5%	7.8%	4.4%
Weighted average	12.4%	6.7%	3.7%

Without public support for farmers, the average contribution rate that satisfies the MF to obtain a loss ratio of 0.65 is 12.4%. If the public support covers 70% of the compensation costs (not including all fund management costs but on indemnities only), the minimum contribution rate required by MF reaches to 6.7%, on average. Clearly, the minimum contribution rate decreases if the public support is calculated over the whole costs incurred by the MF: in this case this rate becomes 3.7% (Table B5).

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Therefore, without public support, interaction between farmers and MFs is possible assuming farmers with medium-high risk aversion only: the minimum contribution rate that an MF could receive is less than the farmers' willingness to participate in the IST at 0.6 risk aversion coefficient (compare Table B4 and Table B5). In the presence of public support, the percentage of contribution rate requested by MF is lower than in the previous case, so that interaction between farmers and MFs is always possible: even risk-neutral farmers could accept.

However, such a minimum contribution rate varies across regions: higher values are found in Piedmont and Sicily (Table B5). These results suggest that carefully consideration should be given to differentiating the contribution levels among regions. Indeed, differences among regions exist in terms of the relative number of indemnified observations (Table B6).

Table B6. Number of cases of indemnification by region and year. Absolute and relative values. Source: Own elaboration on Italian FADN data.

Absolute values (n. obs.)						Relative values (%)				
Year	Campania	Lazio	Piedmont	Sicily	Total	Campania	Lazio	Piedmont	Sicily	Total
2008	1	3	25	2	31	8	30	40	50	34
2009	1	3	31	2	37	7	27	38	50	33
2010	8	5	54	1	68	40	28	66	25	55
2011	6	6	33	2	47	32	20	40	40	35
2012	3	14	35	1	53	23	48	42	25	41
2013	7	13	23	0	43	50	42	28	0	33
2014	3	4	7	2	16	18	17	8	40	12
2015	1	3	12	0	16	5	13	14	0	12
2016	1	3	28	1	33	6	14	34	20	26
2017	1	12	18	3	34	7	55	33	60	36
Total	32	66	266	14	378	20	30	34	30	31

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On average, 31% of the farms are indemnified in the whole sample and the whole period considered; a slightly larger share of farms is indemnified in Piedmont, while, in Campania, the share of indemnified farms drops more than 10% points below the national average (Table 6).

Comparing the riskiness of a national vs. regional MFs

An additional aspect affecting the economic sustainability of the scheme lies in the fact that MF may face high volumes of indemnities paid to farmers in specific years, thereby increasing the level of the loss ratios. When a large number of farms are indeed indemnified, the financial resources available to the MF may be not adequate, making the financial management of the MF untenable unless adequate risk management strategies are pursued actively by the MF. Nonetheless, these strategies come at a cost that, in the end, results in higher contribution rates being charged to participating farmers.

The percentage of indemnified farms at the national level varies over time, from a minimum of 12% (in 2014 and 2015) to 55% (in 2010). Within regions, the variability is even more significant with values between 0% (Sicily) and 66% (Piedmont). This clearly increases of the variability of the amount of indemnities paid by the MF to farmers over the years and this can make the financial management of the MF non-sustainable. If MF were established for individual regions, the percentage of indemnifications could be higher than the national average. This allows adjusting the riskiness for each region, but linking the four regions in a national MF allows risk pooling: the risk to be borne at the level of each region can be distributed at the national level. Hence, in a specific year, the low GM levels experienced by a specific region may be compensated by a high GM level in another region.

Looking also at the level of indemnifications among regions, the total percentage seems to moderate differences among regions (Table B7).

Table B7. Unitary indemnification levels in the regions considered for the indemnified farms. Average over the considered period. Source: Own elaboration on Italian FADN data.

	Campania	Lazio	Piedmont	Sicily	Total
Indemnifications (€/ha)	1,494	1,344	1,608	793	1,522
Average GM (€/ha)	4,999	5,876	5,012	2,569	4,800
%	30%	23%	32%	31%	32%

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To further investigate the riskiness of a unique national MF management instead of separate regional MFs, the evolution of the loss ratios over time was analyzed. It varies strongly among years: in many cases, it exceeds 0.65 (that has been set as the break-even reference level) reaching a maximum of 1.24 in the case of the total sample (Table B8). Here, the variability, assessed as standard deviation, is 0.30. In all the regions considered, such variability is higher than is the one observed in the total sample: in particular, the standard deviation is very high in Campania and Sicily (Table B8).

Table B8. Loss Ratio (Indemnities/Contributions) by region and year. Source: Own elaboration on Italian FADN data.

	Campania	Lazio	Piedmont	Sicily	Total
2008	0.14	0.69	0.96	1.67	0.89
2009	0.08	0.37	0.72	1.42	0.66
2010	1.50	0.47	1.35	0.56	1.24
2011	1.07	0.35	0.74	0.78	0.68
2012	1.19	0.95	0.69	0.55	0.77
2013	1.85	1.15	0.45	0.00	0.67
2014	0.31	0.36	0.13	0.43	0.19
2015	0.07	0.24	0.27	0.00	0.24
2016	0.08	0.41	0.65	0.38	0.56
2017	0.16	1.21	0.63	0.98	0.69
Weighted average	0.65	0.65	0.65	0.65	0.65
Max	1.85	1.21	1.35	1.67	1.24
Standard deviation (sd)	0.69	0.36	0.34	0.55	0.30
Mean	0.64	0.62	0.66	0.68	0.66
Min	0.07	0.24	0.13	0.00	0.19
Semi Stand. Dev (right side)	0.81	0.40	0.32	0.67	0.25

The differences existing among regions are also confirmed by the values of the semi-standard deviation that accounts only for the loss ratios that are higher than the average (i.e., right side semi-standard deviation). This indicator shows clearly that Campania is the riskiest region, having the highest value of this index. It is followed by Sicily and Lazio, while the Piedmont region has the lowest level of risk, indeed it is very similar to that potentially faced by a national MF (Figure B2).[30]

[30] This graph is derived directly from data in table 8 by ordering the data for each region from the highest to the lowest loss ratios.

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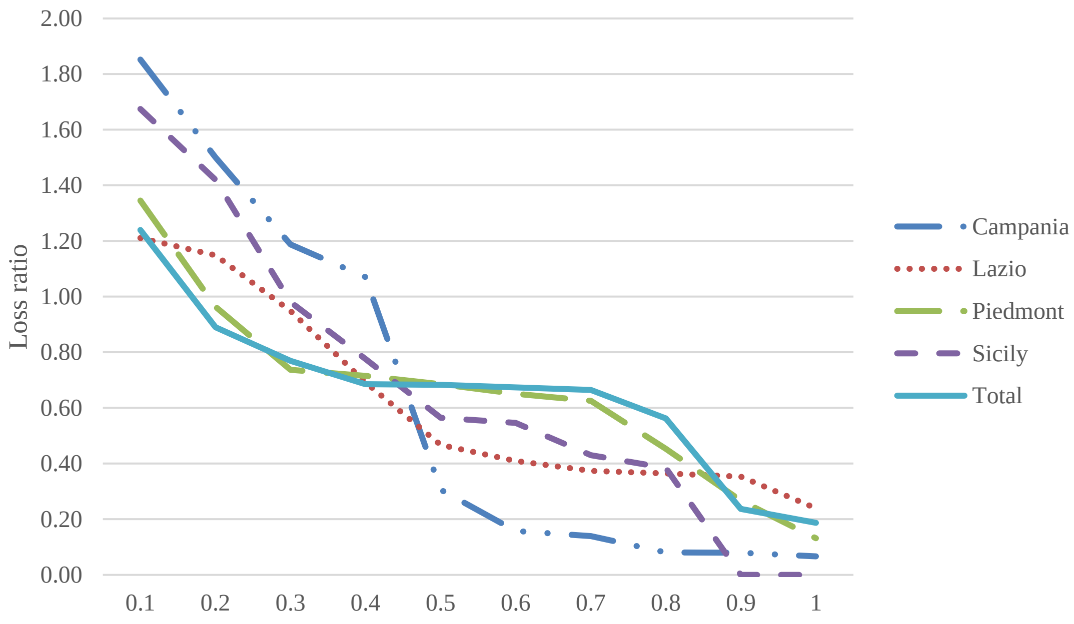

Figure B2. Comparison of Loss Ratio levels by region (Campania, Lazio, Piedmont, and Sicily) and in the case of a national Mutual Fund (Total) in the ten years considered. Source: Own elaboration on Italian FADN data.

These results suggest that managing a national MF is less risky than is managing regional MFs separately. In the latter, the loss ratios can become very high, putting the financial sustainability of the regional MFs under pressure. In contrast, the national MF can more effectively use the risk pooling principle (Trestini and Giampietri, 2018).

Discussion and conclusions

The results of the analysis allow the three research questions described in the introduction of the paper to be answered. This research has shown that the IST could reduce substantially the risk faced by hazelnut farmers in all four production regions of Italy considered: hence, the IST could potentially be very effective in stabilizing their incomes. Furthermore, given the public support provided to the IST, this tool can also enhance farm income. Clearly, this occurs up to a given level of the contribution rate the MF is going to charge associated farmers.

The overall impact will depend critically on the level of farmers' participation in this tool. This paper assessed the conditions ensuring the development of the MF and farmers' participation. The results of the analysis suggest that a sectorial IST for hazelnut farming in Italy could be, in principle, very feasible, because supply can interact easily with farmers' demand. Indeed, in three out of four cases, the maximum extent to which even limitedly risk-averse farmers are willing to

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participate in the IST exceeds the minimum contribution that makes the MF managing the IST financially viable. Hence, there are also opportunities for interactions between the supply and the demand for the IST without sizeable policy support. Clearly, the presence of public support strongly increases the opportunities for developing this new risk management tool. However, it is important to recall that relevant implementation issues not considered in this analysis, including the lack of certified financial statements reporting farm income figures, can hinder the implementation of the IST (Cordier and Santeramo, 2019).

In addition, the analysis provides two pieces of information that are potentially useful for the design of the IST. On the one hand, farmers' contributions should be differentiated among regions because they face different income risk levels. On the other hand, to ensure the financial viability of the MF, it seems important to have a limited fluctuation of indemnities over the years. If this goal is perceived as important, it is advisable to take advantage of the risk pooling principle and opt for a national-wide MF, rather than for single regional MFs. Indeed, regional MFs could face years in which the amount of indemnities paid strongly exceeds the amount of the contributions received. If a regional MF has to be developed, it should manage such adverse financial conditions by collecting larger funds, negotiating the opening of credit lines, or underwriting reinsurance contracts (Pigeon et al., 2014). However, these strategies may be costly and cause an increase in the level of farmers' contributions. This, in turn, is expected to reduce the level of farmers' participation.

In the end, it is important to mention three limitations that affect the present empirical application. First, due to the limited number of sampled farms and the willingness to compare regions where both income levels and risk differ, the analysis refers to the average income calculated over the whole period considered. This is not fully in line with what the EU Regulation that requires the calculation of indemnities based on data from the three previous years. However, the lack of continuous and reliable data, that could effectively hinder the implementation of a sectorial IST, has forced us to use this approach. Second, it is assumed that all farms in a region face the same relative risk by referring to standardized gross margins. If additional data become available, it could be possible to develop an analysis that will overcome these two limitations. Third, the analysis assumes rational behavior, full information and is based on specific assumptions regarding the functional form of the utility function and risk aversion levels. This leads to possible future extension of the analysis toward the use of experimental data to better specify the nature of farmers behavior. Despite these limitations affecting the developed empirical application, it seems that the proposed methodology may be used to assess the implication and feasibility of the IST also in other EU countries, regions, and sectors to yield more widespread results. This is perceived as useful because the results of this kind of analysis can feed

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the debate at the EU level on this new and interesting risk management tool, which is not yet implemented in the EU.

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