20 *Understanding and Addressing the Resilience Crisis of Europe's Farming Systems*

A Synthesis of the Findings from the SURE-Farm Project

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20.1 Introduction

The SURE-Farm project started with the assumption that Europe's farming systems are exposed to a variety of stresses and shocks which could culminate in a significant threat to the delivery of the private and public goods on which Europe's food security, rural livelihoods and many value chains depend. The notion of resilience had been adopted by the European Commission in response to concerns about increasing vulnerabilities of Europe's food systems. However, a comprehensive analysis of the factors that threaten or enhance the resilience of Europe's food systems was lacking. Within this broader context, the SURE-farm project focused on farming systems (see Chapter 1), thereby centring on the production element of Europe's food systems.

The composition of the SURE-Farm consortium emphasized three basic assumptions about what is required to understand and enhance the resilience of farming systems:

- first, a systemic approach that integrates a broad range of disciplines, from agricultural economics and rural sociology to agronomy, agroecology and political science;
- second, a context-sensitive approach that takes into consideration that the characteristics and social and biophysical environments of farming systems differ widely, and hence also their resilience challenges and needs;

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- third, the systematic inclusion of the perspectives and experiences of actors within the farming system and its relevant environment.

To structure the enormous complexity of the topic, the SURE-Farm consortium developed an integrative framework to assess the resilience of farming systems (Meuwissen et al., 2019), which provides guidance to determine the composition and limits of differing farming systems, their main functions, challenges, resilience capacities and resilience-enhancing attributes (Chapter 1). The framework facilitates the identification of the resilience needs of a farming system. On this basis, resilience-enhancing strategies can be developed. These include risk management strategies (Chapter 2), strategies to address adverse demographic developments which lead to a lack of skilled labour and farm successors (Chapter 3), resilience-enhancing public policies (Chapter 4) and resilience-oriented agricultural practices (Chapter 5). The case studies (Chapters 6–16) demonstrate the diversity of resilience challenges, needs and strategies of Europe's farming systems. However, despite the differences, the integrated assessment across the case studies (Chapter 17) and the assessment of stakeholders in the co-creation platform (Chapter 19) clearly show that Europe's farming systems face a resilience crisis and that new approaches are necessary to create a resilience-enabling environment (Chapter 18).

This chapter aims to synthesize key findings from the SURE-Farm project. We first discuss key lessons about the resilience concept as a framework to understand the current resilience of Europe's farming systems and as a tool to develop strategies for improvement. We then establish why Europe's farming systems face a formidable and structural resilience crisis that is unlikely to improve without appropriate resilience-enabling strategies; this section also emphasizes the implications of the diversity of Europe's farming systems in terms of their resilience challenges, capacities and different resilience-enabling or constraining environments. On this basis, we formulate cornerstones for possible resilience-enhancing strategies. The chapter concludes with critical reflections and suggestions for further research.

20.2 Seven Lessons Learned on the Resilience Framework

The SURE-Farm framework to assess the resilience of farming systems builds on earlier work that has translated concepts from the analysis of social-ecological systems to bio-based production systems (Ge et al.,

2016), of which farming systems are one type. Inspired by the panarchy concept (Gunderson & Holling, 2002), the SURE-Farm framework emphasizes the temporal dimension and the interplay across different system levels for understanding the resilience of a farming system. With regard to time, the framework considers both the past and present of a farming system to understand its developmental dynamic (its pathway) as well as its possible future configurations to develop and assess alternative and desired pathways (Chapter 17). With regard to cross-level effects, the SURE-Farm framework emphasizes the interplay between agricultural practices, farm demographics, risk management and public policies for the resilience of a farming system, which are considered as four interwoven cycles (Chapter 1). The concept of the adaptive cycle is used as a sensitizing heuristic to create awareness that the resilience of a system depends on its developmental dynamic, which is symbolized through the four phases of the adaptive cycle: growth, conservation, collapse and reorganization (Holling et al., 2002). The adaptive cycle concept hypothesizes that a "foreloop" is marked by a period of slow, incremental growth, while a "back loop" entails a quick release of resources or loss of structure and creates an opening for reorganization (Gunderson & Holling, 2002).

The experiences and findings from the project lead us to draw the following seven lessons about the resilience concept with regard to farming systems.

Resilience capacities must include anticipation: The SURE-Farm framework distinguishes between three resilience capacities: robustness, adaptability and transformability (Meuwissen et al., 2019). However, in particular the analysis of the responses of the farming systems in the case studies to the Covid-19 crisis (Meuwissen et al., 2021) demonstrated the importance of anticipation as a capacity that enables preparedness (Mathijs & Wauters, 2020). Anticipatory capacities enhance the ability of a system or organization to cope with crises (robustness) and to respond (Duchek, 2019), where responses can pertain to adaptation or transformation. Improved anticipation was emphasized in work on risk management (Chapter 3) and public policies, where in particular a coordinated long-term vision was seen as essential to enhance the resilience of Europe's farm sector (Chapter 4).

While resilience is a latent characteristic of a system, resilience attributes and critical thresholds are good predictors of resilience: Resilience capacities are mobilized in response to shocks and stresses.

Whether a system has been able to cope with and to respond to perturbations can be determined only in hindsight. Moreover, resilience includes the ability to deal with "unknown unknowns". For logical reasons, the resilience of a system to cope with unforeseen events of novel types is difficult to predict. An important implication is that certain system attributes, which are generally associated with higher resilience, do not guarantee that a system can cope with any kind of shock or stress over time. A seemingly resilient system can collapse quickly if an unforeseen event pushes it beyond a critical threshold. Conversely, crises can mobilize unexpected capacities, as became particularly visible in the narrative interviews with farmers about the history of their farms (Chapter 2). Despite these limitations, the resilience attributes of the SURE-Farm framework – diversity, openness, adequate feedbacks, system reserves and modularity – were generally confirmed as relevant predictors of resilience, although the precise materialization of these attributes differs across time, place and scale. During the SURE-Farm project, these attributes were specified for farming systems, and the most important ones in the recent past were: reasonable profitability, social self-organization, infrastructure for innovation, production coupled with local and natural capital, and response diversity (Chapter 17; Paas et al., 2019; Reidsma, Meuwissen, et al., 2020). However, while these attributes are perceived to contribute to robustness and adaptability, the contribution to transformability was questioned by stakeholders, with the exception of infrastructure for innovation, if it is implemented with a vision. In assessing the resilience capacities, the identification of critical thresholds is essential, even if exact threshold values cannot always be determined (Chapter 17; Biggs et al., 2018; Paas, Accatino, et al., 2021). Many farming systems in the case studies seemed robust at first sight but on closer inspection appeared to be operating near critical thresholds. Farming system actors tended to focus on economic viability, as this function was often assessed as close to critical thresholds, and aimed to increase food- and bio-based production, while giving less attention to the maintenance of natural resources, biodiversity and social functions (Chapters 5, 17 and 19). The ensuing deterioration of the ecological and social conditions is likely to undermine productivity and economic viability in the long run. Hence, a strong profile across the range of resilience attributes is more suited than a plain focus on reasonable profitability to enable the system to cope with a larger variety of shocks and stresses (Reidsma, Paas, et al., 2020).

Vision, leadership, shared learning and experimentation, and agility are important resilience attributes: The analysis of demographic dynamics (Chapter 3), of the governance framework (Chapter 4) and several case studies suggests that farms, farming systems and enabling environments that lack a vision found it difficult to respond to shocks and stresses. Strong leadership from either within a farming system or from the enabling environment was found to enhance resilience. Shared learning and experimentation are specifically important for transformability (Paas, Coopmans, et al., 2021; Termeer et al., 2017; Urquhart et al., 2019). The analysis of responses to the Covid-19 crisis (Meuwissen et al., 2021) suggests that agility – i.e. the ability to change internal processes and arrangements quickly in response to a changing environment – constitutes a distinct resilience attribute that enhances robustness, adaptability and transformability. Agility is likely enhanced by shared learning, leadership and vision. Furthermore, agility is supported by anticipation. Overall, these additions lead to more emphasis on the future-oriented, pro-active dimension of resilience and resilience capacities.

General resilience in farming systems requires more than financial buffer resources: Dealing with unexpected shocks requires general rather than specified resilience. Consequently, the resilience attributes play a larger role, as illustrated by the resilience strategies of stakeholders and farmers which emphasized the availability of buffer resources, in particular financial means, but also "working harder" and mobilizing additional family labour (Chapter 2), or public income support (Chapter 4). Savings and subsidies can be exchanged for specific assets or services when needed. Family labour enhances general resilience to the degree that it comes with the necessary skills. Yet the findings indicate that the ability to learn, connectedness with others, innovativeness, creativity and agility are also characteristics of a farming system that increase its general resilience. They are more associated with adaptability and transformability and also facilitate a more creative and innovative use of buffer resources. The analysis also found that coupling production with local and natural capital enhances general resilience by reducing dependence on external inputs, substitutability of own products by competitors and ecological and climate change vulnerabilities.

Non-resilience is difficult to study: The farming systems in our case studies and the farms and other businesses that are part of them have

been resilient, at least up to the point of research. Yet a full comprehension of farming system resilience includes an understanding of its opposite. Unfortunately, it is more difficult to study non-resilience – ceased farm operations, suspended value chains or obsolete farming systems can no longer be observed in operation and the processes that led to their demise must be reconstructed from written records, oral accounts, historical data, artefacts and geological or archaeological findings. The sequence of events is likely associated with failure and people who were involved might be difficult to find or hesitant to participate; records might have been discontinued, artefacts abandoned and land uses changed. Resilience studies must therefore be careful not to embrace a one-sided history of those who persevere and survive. The underlying interest is vulnerability.

Resilience is context specific, and so are resilience needs: The case studies (Chapters 6–16) clearly indicate that the resilience of farming systems depends strongly on their specific contexts. While many challenges to farming systems originate from the same macro-trends – climate change, liberalized markets, geo-political uncertainty, growing societal concerns about pesticides and animal welfare – these pressures are mediated in very different ways, depending on the specific biomaterial, institutional and economic context. The general resilience attributes – diversity, openness, tightness of feedbacks, system reserves and modularity – enable different actions and strategies, depending on the components of each farming system. Furthermore, the enabling environments differed widely across the case studies, with very different and often uneven effects on the different resilience capacities. The practical consequences are significant: the required capacities depend on the circumstances, in particular on the level of uncertainty (Darnhofer, 2014; Meuwissen et al., 2020), while the resilience effects of public policies are subject to specific farming system characteristics (Chapter 4; Buitenhuis et al., 2019; Feindt et al., 2019). Nevertheless, the importance of the general resilience attributes applies to all cases. In the long run, addressing all resilience attributes and keeping a balance between economic, environmental and social functions and attributes contributes to resilience, even if the concrete materialization of these attributes and functions differs across contexts.

Resilience capacities, needs and strategies differ across scales: The panarchy concept emphasizes effects across scales. Accordingly, the SURE-Farm framework distinguishes between the three levels of the

farm, the farming system and the enabling environment. This facilitated the identification of cross-scale effects and misfits (Meuwissen et al., 2020). For example, in response to the Covid-19 crisis, the strategies and actions taken by the farming system often differed strongly from those of the enabling environment (Meuwissen et al., 2021). In another example, the Spanish case study, policies did not take into consideration that the needs of the farmers depend on the characteristics of the farming system (a cross-scale effect) – in this case, extensive sheep grazing farmers used public land and therefore did not receive direct payments, undermining the viability of the system (Chapter 9). The CAP and its national implementations, which are an essential part of the enabling environment, were found to be strongly robustness-oriented (Chapter 4), which fit the resilience needs of some but not all farming systems in the case studies. Moreover, public policies mostly addressed farms and not farming systems. Stakeholders, too, when identifying past strategies to cope with challenges, focused on the farm level, while farming systems encompass many different kinds of actors (Chapters 4 and 5). When stakeholders were asked to identify strategies needed to reach more resilient alternative systems, the focus shifted towards the enabling environment and the role of government (Reidsma, Paas, et al., 2020). Here the resilience framework helped to reveal conceptual shortcomings in the policy framework and to broaden the strategic thinking of stakeholders.

These seven lessons reflect that our conceptual understanding of the resilience of farming systems is not yet complete, and that any general theory of farming system resilience needs to take into account the importance of contextual factors. Still, some general observations about the resilience challenges facing Europe's farming systems can be derived very clearly from the case studies, as we will discuss in the next section.

20.3 The Crisis of Europe's Farming Systems from a Resilience Perspective

The resilience assessment in the eleven case studies found that Europe's farming systems face a broad range of economic, social, political, institutional, agronomic and ecological resilience challenges. While these challenges differ across farming systems and are mediated through different contexts and enabling or constraining environments,

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the general picture suggests that many farming systems in Europe face a looming resilience crisis.

First of all, based on the integrated assessment presented in Chapter 17, and confirmed by the stakeholders in the co-creation platform (Chapter 19), Europe's farming systems struggle to achieve the expected functions, apart from food production. The provision of public goods was generally evaluated as weak or deficient. The profitability of the farming systems was assessed as low in almost all case studies, too. Still, in particular in arable systems, the provision of private goods (production, income) scored significantly better than the provision of public goods (biodiversity, ecosystem services). Nevertheless, stakeholders most often considered economic viability as the most critical function and the one that most urgently required improvement. The dominant concern was that economically unviable farming systems would be unable to attract the necessary workforce and therefore undermine food production.

Across the case studies, an accumulation of challenges was assessed as pushing the farming system towards critical thresholds, i.e. as threatening the continuation of the status quo (Chapter 17; Paas, Accatino, et al., 2021):

- In seven case studies, stakeholders identified *economic challenges* that pushed their system into critical territory. Price fluctuations and low prices were a challenge in all cases, unbalanced value chains in eight and international competition in seven cases. In several case studies, these pressures were exacerbated by issues around technology adaptation, inadequate insurance and dependency on alternative off-farm income.
- All farming systems faced at least two *environmental challenges*, one of them always *climate change*. Other frequent environmental challenges were plant or animal diseases and low soil fertility, but several systems also struggled with water scarcity, excess of nutrients and soil erosion. In five case studies, stakeholders felt that climate change was pushing their farming system towards a critical threshold, and in two cases also diseases.
- In five case studies, stakeholders felt that *social challenges* pushed the system towards critical thresholds, in particular lack of successors, depopulation of rural areas and lack of suitable labour, but

also high societal expectations and changing consumer preferences, poor quality of life and insufficient infrastructure.

- In eight case studies, *public policies and institutional challenges* were seen as pushing the farming system towards a critical threshold. Constantly changing policy regulations were seen as a challenge in ten case studies, high standards and strict regulations in five, complicated administrative procedures and the lack of long-term vision in policy in four and high land prices in three cases. Land ownership and regulation was a challenge in the Polish and Bulgarian case.

The ability to translate these challenges into manageable risks has been limited so far. Exposure to risks is generally expected to intensify for European farm businesses and farming systems in the future, in particular due to climate change, more volatile markets, changing societal demand, policies and regulation, geo-political risks and biosecurity issues such as pandemics and diseases in a globalized world (Chapter 2). From the perspective of farmers, as evidenced by surveys conducted in the case studies, institutional risks (e.g. reduction of CAP direct payments and tighter regulations) and environmental risks (e.g. extreme weather and disease events) generally scored even higher than economic risks (e.g. persistently low market prices and high costs). However, in responses to an open question, long-term pressures on profitability were raised most frequently, and institutional, environmental and economic challenges were complemented by social challenges and difficulties in access to technology and innovations (Chapter 2). Risk management strategies were found to be highly variable across farms (Spiegel et al., 2020). Some farm-level strategies to increase financial robustness – like working harder and avoiding debt – can reduce the capacity to adapt and transform. While learning, cooperation and exchange were found to be essential for appropriate risk management, it were mostly farmers characterized as "proactive learners" who adopted risk management strategies in anticipation of expected challenges, explored new knowledge and engaged across social networks. In contrast, "reactive learners" were found to be risk averse, lacking self-efficacy, oriented towards business-as-usual models and hesitant to adopt new approaches or technologies (Chapter 2).

The case studies found relatively few examples where financial risk management was linked to adaptation or transformation. Discussions in the SURE-Farm stakeholder platform (Chapter 19) revealed

examples of private insurance companies that made compensation for damage from extreme weather events conditional on adaptive measures on the farm; e.g., drought insurance would require suitable water retention management and irrigation systems. Risk management arrangements were generally focused on compensation for income loss from reduced ability to produce private goods. They were barely linked to the public goods which, among their many functions, support the long-term productivity of farming systems.

The ability to attract skilled, highly motivated and entrepreneurial people has become a major challenge for many farming systems in Europe (see Chapter 3). Several detrimental developments are accumulating: first, the general outmigration from the more remote rural areas, which is driven by comparative disadvantages in the general location attractiveness, low-level public infrastructures and social services, limited social opportunities, and barriers to professional and business development due to lack of other business and value chain partners, training opportunities and support structures; second, an increasing mismatch between farming as a long-hours profession with many lonely activities and the lifestyle ambitions of the younger generation; third, uncompetitive income opportunities for skilled labour; fourth, the widely shared reputation of farming as a sector that struggles with issues around environmental and climate protection, animal welfare and social standards (e.g., public debates on the working conditions of seasonal workers and slaughterhouse staff). However, simulations of two case study regions using the AgriPoliS model showed that a difference in farm succession rates had little impact on the amount of farmed land, on production or gross value added (Chapter 3). The simulation runs found differences in the distribution of land and the remuneration of the factors of production. Hence, the discontinuation of individual farms due to lack of successors, which can be seen as lack of resilience at the farm level, affects the developmental pathway of the farming system, but does not necessarily reduce the resilience of the farming system as long as the remaining farms have sufficient access to capital and labour or technology to take over and manage the abandoned land (Chapter 3). However, if farm growth translates mainly into intensification and specialization at ever larger scales, "limits to growth" might be reached at some point as yields are close to their potential and the land area available for farm size increase is limited (Chapters 5 and 17). Concentration of highly specialized farms could

also undermine resilience attributes such as diversity and modularity (heterogeneity of farm types) or coupling of production to local and natural capital.

At the sector level, fewer farm successors and less supply of skilled labour necessitate adaptations which reduce the demand for labour, e.g. by changes to the farm organization and production programme or the deployment of labour-saving technologies such as robotics. This in return requires access to capital and might increase the exposure of farming system actors to financial risks which need to be addressed through appropriate risk management. In order to adapt to the demographic challenges, farming system actors need an enabling environment that provides access to technology and capital and to the skilled labour to implement and run new technologies. Such a technology-intensive scenario, however, might contradict public sympathies for smaller farms and more traditional farming methods.

Many European farming systems are locked in on developmental trajectories that combine a strong reliance on chemical and/or biological inputs with an orientation towards global commodity food systems, as the analysis of three case studies in Chapter 5 exemplifies, based on the typology of farming systems as "socio-technical regimes" by Therond et al. (2017). The exposure to global competition reduces profitability, and the response is intensification with reliance on external inputs and pathways. However, the intensive farming methods are generally not environmentally sustainable since the frequent use of pesticides, the ample addition of nitrogen and phosphorus, irrigation, tillage, landscape simplification and the emission of greenhouse gases have negative impacts on ecosystem functions and natural resources. In the long run, sustainability deficits are likely to undermine the resilience of the farming systems through, e.g., soil erosion, reduced water quality and quantity, and decline of ecosystem services such as pollination, water retention or buffer against extreme weather (e.g., wind breaks, shadow, flood protection). Changing the developmental trajectory of the farming systems, however, is difficult due to economic, institutional, cultural and social lock-in mechanisms (cf. Burton & Farstad, 2020). While participating stakeholders in the case studies identified pathways towards a more sustainable development of their farming systems, these require support from an enabling environment, in particular public awareness of the linkages between farming systems and ecosystem services, coherent government support for the provision

of public goods, targeted advice and training, valorizing environmentally sustainable products, support for cooperation and for local and regional value chains. Stakeholders also called for supporting technologies, in particular better use of environmental and geo-spatial data, which could be developed inter alia through farmer-led innovation processes. Finally, they suggested to facilitate cooperation to foster knowledge exchange, trust and a sense of community.

The stakeholder evaluation of the public policy framework provided by the CAP and its national implementations was very critical (Chapter 4). An analysis of the CAP instruments and budget found that most of the financial resources were devoted to income support measures, in particular area-based payments. These were broadly perceived as a reliable financial buffer that enhances the robustness of farms. However, several negative side-effects on the robustness of farming systems were identified: area-based direct payments increased competition for eligible land and thereby contributed to rising land prices, which in turn constrained access to land for newcomers and reduced the profitability of farms that work on leased land. By enabling otherwise unprofitable and unviable farms to continue, stakeholders concluded, the payments restricted competition and change. At the same time, the area-based direct payments funnelled very few resources into farming systems that use little eligible land.

Attempts to link income support to the provision of public goods and thereby to stimulate adaptation have been mostly ineffective (Chapter 4). The Rural Development Programs (RDPs) contain a few adaptability-oriented measures that encourage environment-friendly farming practices, social learning, cooperation and innovations. However, complex and bureaucratic application procedures, significant up-front costs, slow programming and lack of flexibility limit the potential of RDP measures to enhance adaptability. Financial support for insurance schemes, another policy option in RDPs, could be expected to form a key element to enhance robustness, in particular to address losses from climate change and extreme weather. Yet, where offered (in the Dutch and Polish case), it was mostly met with reservation by stakeholders due to perceived high financial or transaction costs and lack of trust.

Most concerning was the finding that the CAP constrained the transformability of Europe's farming systems (Chapter 4). This assessment was consistent across methods. The top-down analysis of the

policy instruments found that the CAP provided strong support for business-as-usual approaches – which should not be an option, given the objectives of the Green Deal, the Farm to Fork strategy and the EU's zero emission ambition, all of which require transformative change (Lóránt & Allen, 2019), and that many farming system actors also expressed the need for transformation (Meuwissen et al., 2020). The bottom-up analysis found that respondents in all farming systems felt that the CAP and other policies provided little long-term guidance. They cited too frequent policy changes without a clear sense of direction. Stronger regulations on animal welfare and the use of manure or pesticides without readily available alternatives were seen as threatening the viability of farms if international competitors were not subjected to similar demands.

It also became clear that networks and learning processes were mostly limited to farmers. This tendency was reinforced by the CAP and its national implementations which offered little support for cross-sectoral cooperation, in-depth learning or radical innovations. The relatively closed networks within the farming systems could in turn constrain the potential of policy interventions which aim to introduce new actors, knowledge or perspectives (Chapter 4).

The tendency to operate within relatively confined circles is probably one important reason why several problematic patterns were repeatedly found across case studies (Chapter 18). Shifting the burden to third parties who provide additional support and compensation, eroding goals rather than addressing problems, an enabling environment that constrains efforts to develop and implement novel solutions, or allocation of most of the resources to a limited number of well-established solutions are examples of unhealthy dynamics, which are systemically entrenched, difficult to recognize and hard to change. They all contribute to a misallocation of resources to reiterate the responses to problems of the past rather than addressing impending and future challenges.

Overall, the analyses in the SURE-Farm project suggest that many European farming systems face an accumulation of challenges that push them towards critical boundaries. While the systems still perform well with regard to food production, profitability is low and the provision of public goods is often not satisfactory. Lack of profitability and other social and economic opportunities in rural areas reduce the interest of potential farm successors and skilled labour to work in the

sector. While scale enlargement and intensification have contributed to robustness in the past, there are limits to growth, and a more balanced attention is needed for economic, social and environmental dimensions. The CAP and other public policies are geared to compensate for a lack of robustness in order to maintain a status quo that is increasingly becoming untenable. While the EU is embracing ambitious long-term goals, e.g. in its Farm to Fork Strategy (European Commission, 2020b), the transformation pathways are unclear and not supported by the current policy instruments. This raises the question of what a coherent strategic approach to enhance the resilience capacities of Europe's framing systems could look like.

20.4 Resilience-Enabling Strategies

The need to develop encompassing strategies to enhance the resilience of Europe's food systems is now widely shared. The Farm to Fork Strategy, which the European Commission (2020b) proposed in May 2020, uses the terms "resilience" and "resilient" fourteen times. The experience of the pandemic has visibly generated a sense of urgency: "The COVID-19 pandemic has underlined the importance of a robust and resilient food system" (p. 3), and, with a view to the "interrelations between our health, ecosystems, supply chains, consumption patterns and planetary boundaries", the Commission concludes that "our food system is under threat and must become more sustainable and resilient" (p. 3). The Commission further calls to strengthen the resilience of Europe's food system (p. 5) and of food systems in general (p. 6). The Farm to Fork Strategy mentions several threats to resilience when it calls to increase climate resilience (p. 6) and to build up resilience to possible future diseases and pandemics (p. 18). The European Commission (2020b) also proposes several resilience-enhancing attributes of farming systems: "increasing the sustainability of food producers will ultimately increase their resilience" (p. 12), and "short supply chains which increase the resilience of local and regional food systems" (p. 13).

Given the diversity of Europe's farming systems, their resilience challenges and capacities, it is not possible to formulate one resilience-enhancing strategy that fits all. However, based on the findings from the SURE-Farm project, we can formulate lessons and principles that can help farming system actors and their enabling

environment to develop strategies that enhance the necessary resilience capacities.

The resilience strategies articulated by stakeholders during the workshops often focused on reduced costs. This, however, is unlikely to enhance adaptability or transformability. Only when asked how their systems could move to an alternative constellation, stakeholders suggested a broader range of strategies that can be divided into four groups (Chapter 17):

- Economic viability: enhancing the profitability of the farming system and providing financial support;
- Social connectedness: better cooperation among the actors within the farming system, improving social self-organization, improving consumer-producer relationships, improving connectedness with actors outside the farming system, such as the Agricultural Knowledge and Innovation Systems (AKIS) and policymakers;
- Ecological connectedness: enhancing coupling with the local and natural capital, promoting circularity or crop–livestock integration, enhancing functional diversity;
- Supportive policies: diverse policies and simplification or relaxation of regulations, more support for public goods.

The overall consideration is that actors within and outside the farming systems need to collaborate to enable a transformation towards novel business models that address the long-term challenges of farming systems (Reidsma, Paas, et al., 2020). To address the range of resilience challenges, it is important to develop strategies that link up across the four domains of agricultural production, risk management, farm demographics and governance.

First, there is a need for a *joined-up vision on agricultural production and food systems in Europe*. On the bright side, food production was consistently seen as the most important and best-performing function of Europe's farming systems. But the emerging bioeconomy with its demand for biomass might demand changes to production programmes. The protein gap for animal feedstuffs persistently drives imports and leakage of environmental problems to other parts of the world. Under competitive pressure, many farming systems reduce resilience attributes such as diversity and modularity in the interest of specialization and economies of scale. Adaptation to climate change was a major concern in all case studies. And the relatively poor

performance of public-goods-related functions requires more environmentally friendly forms of production. In order to meet the Sustainable Development Goals (and the objectives of the Farm to Fork Strategy), especially in north-western European countries, reductions in pesticide use, nitrogen surplus, greenhouse gas emission and share of protein supply of animal origin, along with an increase in nitrogen use efficiency, are needed (Gil et al., 2019). Furthermore, the EU's Biodiversity Strategy (European Commission, 2020a) calls for a reduction of farmed land, while the Farm to Fork Strategy's objectives of reduced use of pesticides and fertilizers along with 25 per cent organically farmed land imply lower productivity on the affected areas (although it can be argued that considering the overuse of inputs in many places, farm productivity can remain at similar levels when inputs are used more efficiently). Any shortfall must be made up of a combination of more intensive production on the remaining land, reduced food loss and waste, imports and reduced or less land-consuming consumption patterns (i.e., less meat consumption). A further yield increase has little leeway in Europe, especially in the north-western countries where yields have already reached 70 per cent or more of their potential (Schils et al., 2018; Silva et al., 2017). There is hence a need for an integrated assessment of food and non-food needs and priorities and a vision of what Europe wants to produce on its agricultural land and how.

This should include a *vision of resilience-enhancing agricultural landscapes* (i.e. rural landscapes shaped by agriculture) and how they can be maintained, restored or created. This should be guided by the functions of the farming system and landscape and resilience-enhancing attributes, such as diversity, modularity and system reserves. Such an approach would in particular recognize the functions of landscape elements and ecological services for agricultural production, in addition to social connectedness. Discussions should be guided by an analysis of critical thresholds. The compatibility of the overall European and the regional visions need to be ensured through a bidirectional, iterative process, enhancing reflexivity of visions across scales (Feindt & Weiland, 2018). In order to improve sustainability and resilience of farming systems, agricultural production needs to be better coupled with local and natural capital, which includes improving soil quality and circularity, reducing inputs, using varieties that are adapted to local climatic conditions, and local branding. Further potential for strengthening ecological processes lies in increasing

functional diversity and creating ecologically self-regulated systems (Chapters 5 and 17).

A more integrated, resilience-oriented approach to agricultural production and resource management entails the need for *a skills-oriented vision of farm demographics*. Currently, farm demographics in Europe are characterized by mutually reinforcing structural restrictions. Intergenerational transfer of the farm within the family remains the main route of succession. The family farm model helps to overcome entry barriers like access to land and capital and also enables the mobilization of additional resources like (unpaid) family labour and private savings. The analyses in the SURE-Farm project also emphasize the importance of personal relations and networks for access to land, capital, business opportunities and knowledge. Such barriers would constitute less of a restriction for the development of farming systems if there was an ample pool of interested people. However, many rural areas are perceived as not very attractive and provide fewer opportunities for social life, education and public services. The lack of successors and skilled labour as well as the barriers for new entrants are likely to reduce the adaptability and transformability of farming systems since they constrain the influx of new ideas and fresh thinking. Since innovativeness and entrepreneurship are scarce skills, agricultural systems have to compete with other sectors.

Hence, from the perspective of the resilience of farming systems, the issue is less whether farms find a successor within their family rather than the *encouragement of successors and skilled people who embrace an integrated vision of farming that includes the sustainable provision of both public and private goods*. Chapter 3 elaborates a range of strategic measures to address these demographic issues. They range from enhanced attractiveness of rural areas to territory-based instruments, skills training that is consistently oriented towards strengthening sustainable agricultural practices, the opening up of networks, improved conditions for start-ups and new entrants to facilitate new business models, joined-up risk management along all stages of generational renewal, support with mental health issues and reinforcing the positive effects of cooperation, peer exchange and learning cycles.

An alternative strategy would be to substitute scarce labour with technology, such as ICT and robots, and to bring in new concepts and ideas through training and education, advisory services, service providers and knowledge included in "smart farming" products. But this

raises important questions about the availability of capital to acquire technology and knowledge-based services, the speed of development of such new technologies, and their compatibility with incumbent farmers, their skills, practices and business models.

Finally, the discussion of farm demographics leads to the broader question of whether the current mechanisms that determine which farms are discontinued are conducive to the resilience of farming systems. From an evolutionary perspective, the take-over of unsuccessful and dysfunctional farms by more successful competitors can enhance system performance. However, a systemic and guiding vision of how farm demographics can be linked to improved functionality and resilience of farming systems is lacking – apart from supporting measures like education, training and start-up grants.

Risk management in the case studies of European farming systems was found to be generally status quo oriented. To address the resilience challenges, *more synergies are needed between financial risk management and support for other desired functions of farming systems*. Again, there is no one-size-fits-all solution. The diversity of farming systems and the variegated risk landscapes require a *diversity of risk management strategies*. Chapter 2 identified a number of strategy elements. These include a full mapping of risks facing each of Europe's agricultural systems and the available risk management tools to identify gaps and mismatches, the deployment of financial risk management (insurance schemes) to incentivize adaptation, the use of novel technologies to develop new risk management tools and innovative insurance mechanisms, and the encouragement of cooperation, learning and sharing of risks between all actors in the farming system, not least through differentiated strategies that address different needs (Vroege & Finger, 2020).

The strategies to improve agricultural practices, risk management and farm demographic require an enabling environment. The *principles to create a resilience-enabling environment for farming systems* presented in Chapter 18 provide some general guidance: emphasis on the development of anticipatory and responsive capacity; transfer of external resources to address shocks but not to compensate long-term stresses; adaptation or transformation to increase robustness to challenging long-term trends; fostering the capacity for response diversity; ambidexterity to respond to both current and future challenges; thorough analysis of the root causes of challenges.

The policy framework is the most important part of the enabling or constraining environment. The analyses in the SURE-Farm project found a clear *need for more tailored policy mixes that address the specific resilience needs of Europe's farming systems*. The CAP is the dominant policy for Europe's farming systems. It provides the overarching policy framework for most national and regional policy initiatives, equipped with a budget of more than 50 billion Euros per year, most of which is spent on income support through area-based direct payments. This is broadly understood to support the robustness of Europe's farming systems while support for adaptability is limited and transformability is rather constrained by the status quo orientation. However, strictly speaking, income support does not increase resilience, it rather compensates a lack of resilience. Hence, instead of stretching the resilience concept to justify policies that have been inherited from the past, it is necessary to *develop a proper resilience foundation and resilience orientation for the CAP*.

A revised CAP could enhance all resilience capacities of Europe's farming systems (Buitenhuis et al., 2020). To foster the *robustness* of Europe's farming systems, the CAP should enhance the ability and willingness of farming system actors to anticipate stresses and shocks and to develop their own coping and response strategies, and conduct foresight exercises linked into strategy development and outreach and engagement schemes. To enhance *adaptability*, the CAP should provide a coherent and sufficient remuneration of public goods; increase flexibility and variability through reducing red tape; provide more support for project-type funding, for AKIS that integrate production and provision of public goods, and for collaboration between agriculture and societal actors. To enhance *transformability*, the CAP should formulate a coordinated long-term vision; support deep learning; adopt reflexive modes of governing that influence people's assumptions about the future, their self-perceptions and identities; develop EIP-Agri and LEADER into cross-sectoral support for rural cooperation; and embrace cross-sectoral approaches in rural development programs.

Overall, the CAP needs a long-term vision for resilient and sustainable farming systems. The Farm to Fork Strategy is one important step into this direction.[1] The immediate SURE-Farm recommendations for

[1] The European Commission (2020b) clearly has doubts whether the historically grown CAP provides a resilience-enabling environment when it calls for an

the CAP were to *reduce direct payments* with a view to phasing them out by 2028 and to divert the budget into those CAP measures that specifically address resilience needs. The *eco-schemes* should be used to foster public goods (e.g. biodiversity, attractive landscapes) and adaptation to environmental and climate change. The member states' *national strategic plans* should primarily support adaptability to meet the ambitions of the Green Deal, the Farm to Fork Strategy and the Biodiversity Strategy. Member states should provide ample support for cooperation and cross-sectoral networking in rural development programmes and enable producer organizations to coordinate adaptation to shifting markets and changing environments. The AKIS should be strengthened through more project-type funding and more funding for advisory services to integrate advice for production and provision of public goods. The RDPs should enable transformative innovation, reflexivity and deep learning through more support for LEADER projects and European Innovations Partnerships (EIP-Agri).

The importance of cooperation, exchange and learning emphasized above is also essential to make a resilience-oriented policy approach effective. The case studies consistently found that active engagement in social learning processes was important to empower farming system actors to understand policies and make effective use of funding and support opportunities (Chapter 4). Resilience-enhancing policies require a dedicated support infrastructure, whereas direct payments can be administered through clerks and inspectors.

Several of the case studies found an important role of more hybrid governance arrangements that combine private and public elements. Vertical coordination along value chains or horizontal coordination by producer organizations was often instrumental in coordinating adaptation or even transformation of farming systems (e.g. Chapters 11 and 12). This resonates with the literature on hybrid food governance which has found numerous constellations where actors from the

evaluation "to establish the contribution of income support to improving the resilience and sustainability of farming" (p. 10, fn 24). It points to several elements of a resilience-enabling environment: a contingency plan in times of crisis (p. 12), prevention of fraud which "undermines the resilience of food markets" (p.15), investment support to improve the resilience and accelerate the green and digital transformation of farms (p. 17), cooperation to improve nutrition and to alleviate food insecurity by strengthening resilience of food systems and reducing food waste (p. 18), and "international cooperation to enhance resilience and risk preparednesss" (p. 18).

public, private and civil society sector collaborate to enable fairer or more sustainable value chains (Verbruggen & Havinga, 2017). These arrangements are often dominated by food processors or retailers, which raises questions about market power. It is also clear that these meso-level assemblages are not the original drivers of sustainability and resilience, but enable coordinated responses to changing framework conditions and challenging macro-trends that require sustainability-oriented and resilience-enhancing strategies.

A little-discussed element of the enabling or constraining environment concerns the *role of markets, or the political unleashing or harnessing of market mechanisms*. Stakeholders in all case studies insisted that enhancing the robustness of farms and farming systems requires to improve their profitability. The liberalization of Europe's agricultural markets since the MacSharry reform of the CAP and the EU's Eastern enlargement since 2005 have increased competition for most farmers. The shift in the provision of income support from managed markets to area-based direct payments reduced state-induced market failure – the old system of market interventions had suppressed price signals as a feedback mechanism between supply and demand, which had led to overproduction and generated ever new needs for government intervention. However, since the managed markets have been widely abandoned, other market failures have become more pertinent. Many externalities of farming have not been internalized in the price for marketable goods, e.g. greenhouse gas emissions, landscape amenities or habitat quality from structural elements in the agricultural landscape. Internalising these externalities would increase costs and further reduce competitiveness in open markets, unless border adjustments are put in place.

From the perspective of many farming system actors, the tension between price pressure on internationally competitive markets and increasing demands to cater for public goods has not been solved. On open markets, the use of less productive farming methods reduces international competitiveness and justifies – or even requires – compensation. Yet the instruments used to remunerate public goods are rather bureaucratic and inflexible and do not stimulate learning, flexible solutions or entrepreneurship. In the long run it would also be very expensive for Europe's tax payers to recompense the provision and maintenance of all public good components associated with Europe's farming systems. Hence, a resilience-enabling environment needs other

market configurations, such as the inclusion of higher sustainability standards in transnational public or private regulations, border adjustment mechanisms, or the development of new markets that enable the internalization of externalities, such as carbon emission certificates. A comprehensive and long-term resilience strategy for Europe's farming systems needs to engage with these broader questions of the political economy of farming.

20.5 Reflections and Outlook

While the SURE-Farm framework and analyses have generated substantial results, a number of limitations need to be acknowledged.

First of all, the *scope of the SURE-Farm concept* is limited to farming systems. While the shift of attention from the farm level to the farming system level has already been challenging, an even broader approach is needed. The EU Farm to Fork Strategy emphasizes the resilience of entire food systems, and calls have been made for a more encompassing integrative food system approach. The exclusive focus on farming systems tends to reproduce the productivist, producer-oriented outlook of farm policy in general and the CAP in particular (Daugbjerg & Feindt, 2017), unless it is understood to include the resilience of the entire value chain, including specific vulnerabilities of different consumer groups. There is hence a need to put farming system resilience into the wider context of food system resilience and sustainability. For the successful transformation of food systems in order to meet climate change targets, Europe will need farming systems that are both sustainable and resilient. Without resilience it will be difficult for farming systems to be sustainable. But Europe also needs farming systems that enhance the resilience of Europe's public health. This implies, e.g., that the functions of farming systems should include their contribution to healthy dietary patterns or food-related illnesses, or that the use of antibiotics in animal breeding does not create life-threatening vulnerabilities in the health system.

Second, the framework could strengthen the *critical assessment of the functions provided by farming systems*. Currently, the SURE-Farm framework contains eight generic functions – production of food, production of other bio-based resources, economic viability, quality of life, maintenance of natural resources, protection of biodiversity and habitats, attractiveness of the area as well as animal health and welfare.

The perceived importance and level of performance of each function was assessed, complemented by a quantitative assessment for some ecosystem services indicators. This allows to identify unbalanced or low levels of performance of the system. However, one might also ask whether each function is addressed in the most desirable way – this would require a reflection on, e.g., the type of food and other resources produced, the distribution of economic gains, the underlying ideas about quality of life, the instrumental or intrinsic valuation of natural resources, biodiversity and habitats, productivist or post-productivist perceptions of landscape attractiveness, and differing concepts of animal health and animal welfare (Feindt & Weiland, 2018; Marsden, 2013). The social standards of valuation for each function are historically contingent and in pluralist societies they are usually contested. Hence, even if the eight categories provide a complete taxonomy of farming system functions, different distributions of importance given to them, or different ideas about the best manifestation of each of them, can lead to very different concepts of a good and desirable farming system. It is likely that future policies and governance arrangements will put more emphasis on public goods, animal welfare and climate friendliness. Since the resilience analysis starts with the challenges and since low performance of functions is one type of challenge, new understandings of each function or shifting weights between them likely affect the overall assessment. Including alternative manifestations of functions into the resilience framework would require a counter-factual analysis. To a certain degree, this was implied in the FoPIA-SURE-Farm 2 workshops (Chapter 5, 17 and 19) when participating stakeholders were asked to think about alternative systems. These exercises revealed a high degree of path dependence. The articulated imagination of stakeholders was strongly shaped by their understanding of the current system, and participating stakeholders came mostly from the current system. It would therefore be necessary to involve a broader range of perspectives, e.g. by inviting "critical friends". Another option would be to stimulate thinking out of the box, e.g. by confronting stakeholders with alternative scenarios. Yet, the experience in workshops was that stakeholders from the farming systems found it difficult to engage with scenarios that they felt were remote from their lifeworld experience, or to imagine alternative farming systems that would focus on different products.

Third, the SURE-Farm project did not develop a definitive set of a small number of *indicators to measure the resilience of farming systems*. One reason is that the SURE-Farm framework comprises a large number of incommensurable entities. Furthermore, the relationship between the resilience attributes and resilience capacities appears to be context-dependent. Nevertheless, it is conceivable to create a resilience scale from the various scales that have been deployed during the project, e.g. the Resilience Assessment Tool for policies (Termeer et al., 2018), the performance indicators for farming system functions (Chapter 17) or the assessment of resilience attributes (Paas, Coopmans, et al., 2021; Reidsma, Paas, et al., 2020). An important aspect is to measure resilience attributes – but these are difficult to operationalize, and determining a "good" level of, e.g., diversity or tightness of feedback is an intricate task. The operationalization into twenty-two more specific attributes (of which thirteen were assessed in stakeholder workshops) including explanatory statements, which could be assessed with a participatory approach, was one step towards such a measurement, but remains qualitative (Paas et al., 2019). An alternative approach is to measure system outputs, outcomes and the performance of system functions using representative indicators – the identification of problematic trends can serve as an early warning system for system decline (Chapter 17; Paas, Accatino, et al., 2021). Quantitative models can be used to assess specific indicators, but quantification is generally limited to a few specific indicators (Herrera, 2017).

Fourth, the *concept of the adaptive cycle*, an influential concept in resilience thinking (Gunderson & Holling, 2002), has been used as a heuristic to sensitize researchers to the processes of decomposition of a system and reorganization of its resources (Reidsma et al., 2019). However, attempts to determine at which stage of the adaptive cycle farming systems are found have met with difficulty (see case study Chapters 6–16). For example, should risk management be assessed as growing or reorganizing? Many farming systems seem to be in the conservation phase, but does that imply that collapse and reorganization are the next phases, or can deliberate transformation be achieved by smaller, shorter and more manageable cycles in the conservation phase? It also turned out that the concept was difficult to apply to a system marked by fragmented (polycentric) agency and resources.

Fifth, *the resilience concept requires further methodological integration*. The SURE-Farm project deployed a range of qualitative (mostly participatory assessments) and quantitative methods (mostly based on data and models). These were united through an Integrated Assessment (IA) toolbox that consisted of the Framework of Participatory Impact Assessment for Sustainable and Resilient Farming Systems (FoPIA-SURE-Farm), an ecosystem services assessment and the AgriPoliS model, and a system dynamics approach using causal loop diagrams (see the overview in Chapter 1). Integrating the results from the different methods proved all but easy. Most of the academic outputs so far built on just one method. While a mixed-methods approach is beneficial or even necessary for understanding such a multi-faceted concept as resilience, its empirical application remains challenging. Chapter 17 provides an overview, but neglects most results from quantitative models, as these focused on one or a few challenges, indicators and/or case studies, because of the complexity to quantitatively analyse a farming system. A particular barrier is the integration of multiple methods within one academic journal paper. Here, the dominant publication culture constitutes a significant restraint. Proper mixed-methods approaches require more extensive formats to sufficiently explain and make each method transparent.

Sixth, there is a need to *reflect and address more systematically how actors understand resilience*. As explained by Giddens's concept of a "triple hermeneutics", resilience is an academic concept that has been taken up by societal groups and actors, in the process acquiring new meaning-in-practice, which in turn needs to be reconstructed by academic researchers (Giddens, 1984). The resilience concept will always be interpreted and used in the context of dominant discourses and actors likely pick up elements of the resilience concept that resonate with their worldviews. The different resilience capacities emphasize either the need to defend or to change the status quo, thereby reverberating with different values. It is then to be expected that actors selectively adopt or mix elements of the resilience concept. Even more, its different aspects make the resilience concept politically ambiguous, and this ambiguity can be rhetorically exploited to create a consensus frame (Candel et al., 2014) that conceals significant disagreements.

Seventh, there is a *need to develop more thorough foundations of resilience governance, at least with regard to farming systems*. The strategies identified to enhance the resilience capacities of farming

systems require strong coordination of a broad range of actors with different interests, ideas and identities. This raises the question about the necessary coordination capacities. If the resilience of a farming system is a collective good, collective action (Ostrom, 1990) of the system members is required to retain it. If resilience is an emerging property of a farming system that results from the interactions of its elements, an enabling environment is needed to "supervise" the system's direction of development and create suitable context conditions, more akin to reflexive governance approaches (Feindt & Weiland, 2018). If the resilience challenges and needs differ across Europe's farming systems, what is the appropriate level of policy interventions to create an enabling environment? How do resilience strategies relate to established principles of good governance, such as the subsidiarity or the polluter-pays principle? What are principles of a resilience-oriented policy design (Feindt et al., 2020)? The context dependency of the effects of public policies on resilience suggests that a shift in programming capacities in the CAP from the European to the national and regional level, as implied in the "New Delivery Model", is preferable. But this requires strong coordinative capacities at the regional level and in the farming systems. At the same time, stronger coordination is not always better. The Dutch and Flemish case studies, e.g., pointed to disadvantages if coordination within the farming system is too strong and farmers stop thinking for themselves. There is a fine line between coordination and paternalism. In contrast, the Spanish case demonstrated the benefits if a strongly coordinated sector successfully lobbies the government.

Despite these shortcomings, the SURE-Farm analyses clearly indicate that the resilience capacities of many of Europe's farming systems are likely not sufficient to address the accumulating resilience challenges and to maintain the provision of private and public goods at desirable levels, when new encompassing strategies are not developed and implemented. The stakeholder involvement found widespread concern about long-term vulnerabilities, while at the same time a significant number of actors are currently successful and happy with the dynamics, indicating a mismatch between individual and collective rationales as well as between short-term and long-term interests.

In the long run, the development of the resilience attributes will be essential – and here many trends are going into the opposite direction: economies of scale rather than diversity, consolidation rather than

modularity, separation of consumers and producers rather than tightness of feedbacks. Translating the academic findings into practical strategies would begin with a broad agreement on the need to reverse course, i.e. on the need for a transformation. The resilience assessment can help to identify problematic trends, even if the consequences of the long-term deterioration of environmental and social functions have not yet fully materialized. Here the SURE-Farm framework can be used to conduct a participatory assessment of the situation of a farming system and derive the resilience needs (Paas, Accatino, et al., 2021; Paas, Coopmans, et al., 2021). Hence, the framework can serve as heuristic and then be supported with relevant data.

Many farmers in the SURE-Farm case studies shared a sentiment that "the next generation must do it differently" and expected that they would do it differently. This perspective betrays at the same time a sense of crisis, a lack of self-efficacy and a delegated optimism. It also confirms that it is difficult to start the transition of farming systems, given the combined and mutually reinforcing lock-in mechanisms of vested interests, entrenched mental models, historically grown regulations, policy legacies and sunk investments.

Against this background, the weaknesses of the resilience approach need to be addressed – both for academic and for practical reasons. While the SURE-Farm project has been able to develop a systematic framework to assess the resilience of farming systems and generated a plethora of evidence from the case studies, many important questions remain. We suggest in particular *five avenues for future research*:

1. Resilience assessment: There is a need for systematic assessments of the vulnerabilities of farming systems and food systems more broadly. It would be worthwhile to develop a coherent methodology for conducting stress tests of farming systems that consider a broad range of accumulating stresses and shocks. This would include, inter alia, scenario development and a system to rank the severity and likeliness of a broad range of perturbations.
2. Resilience and sustainability: The relationship between resilience and sustainability of farming systems appears more problematic at the end of the SURE-Farm project. Unsustainable farming systems can be resilient as long as their lack of sustainability does not undermine their viability. Generally sustainable farming systems can lack resilience, such as the extensive grazing system in the

Spanish case study. The finding that public goods were not in a good condition in many farming systems in the case studies while resilience strategies mostly focused on robustness and the provision of private goods suggests the possibility that short-term and medium-term resilience could be enhanced at the expense of long-term resilience and sustainability. Clearly, the relationship between resilience strategies and sustainability requires more attention.

3. Transformative capacities: While the case studies generated a good understanding of robustness and adaptability capacities of farming systems, transformative capacities are much less understood. Stakeholders were not convinced of the contribution of the main resilience attributes to transformability, with the exception of "infrastructure for innovation" (Reidsma, Paas, et al., 2020). Transformative capacities are difficult to assess, as deliberate transformations of farming systems rarely take place, and if they do, they generally take a long time and can often only be analysed in hindsight. The SURE-Farm framework considers changes in the materialization or weight of functions delivered by a farming system as one possible transformation. Yet, this was rarely observed in the case studies. Farming system actors and also the enabling environment were mostly oriented towards maintaining and preserving current functionality. Production methods were intensified and food production increased, but the main functions and representative indicators (e.g. starch potato production in the Dutch Veenkoloniën, see Chapter 12) did not change. This limited the willingness and ability to consider alternative constellations that would include modified and possibly enhanced functions. One avenue for further research would be historical studies of farming system transformations, in particular transformations that involved modifications of system functions (e.g., Termeer et al., 2019).
4. Resilience attributes: The five core resilience attributes – diversity, openness, tightness of feedback, system reserves and modularity – deserve further analysis and possible revision. They are currently pitched at the level of structural characteristics. However, an analysis of the responses of the eleven farming systems in the SURE-Farm case studies to the Covid-19 crisis found that agility and leadership were essential for the resilience of the farming systems to the unexpected shock of the pandemic (Meuwissen et al., 2021). For participatory assessments, a list of twenty-two more specific attributes was

developed based on Cabell and Oelofse (2012), and reduced to thirteen to facilitate discussion (Paas, Coopmans, et al., 2021; Reidsma, Meuwissen, et al., 2020). It was clear that sustainable and resilient systems require a strengthening of attributes in the economic, social, ecological and institutional domain (Figure 17.2), but a quantitative assessment of the necessary minimum levels is still lacking.

5. Resilience strategies: The case studies revealed that it is not well understood how transformative capacities of farming systems can be stimulated. It is clear that anticipation and foresight, visioning, learning, open attitudes, connectedness and societal support play a role. However, these elements still need to be integrated into a clear framework that can guide experiments and comparative case studies of farming systems. In particular, we need to understand better how resilience strategies can simultaneously enhance public and private goods.

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